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A CRITIQUE OF THE PPS GAIN VARIABLE AS A PREDICTOR OF HOSPITAL RESPONSES

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A CRITIQUE OF THE PPS GAIN VARIABLE AS A PREDICTOR OF HOSPITAL RESPONSES

1.0 INTRODUCTION

In evaluating the impact of PPS on hospitals, the researcher is faced with a difficult design problem. Because the program was implemented nationally (except for the four waivered states), no real control group is available for comparison purposes. Such a group is important in quasi-experimental design research because of our inability to explicitly control for other factors besides PPS that may explain observed differences in hospital performance after implementation of PPS. These might include the accelerating shift to outpatient surgery in 1983, the growing rigor of private insurer utilization review, and the diffusion of new technologies.

Our evaluation strategy to control for extraneous forces was to "introduce" cross-sectional variation in the hospital sample pre and post-PPS, essentially creating an "internal" control group. To accomplish this, we developed two measures of the ex ante GAIN hospitals might have expected in switching to a fixed prospective payment per discharge from cost-based reimbursement. One considered the immediate gain or loss in the first year; the other incorporated the effects of a fully phased in national rate.

This paper is a limited critique of the GAIN variable as a method for isolating PPS effects. It is limited in the sense that no empirical work is undertaken. Only a conceptual and methodological discussion is provided.

The next section summarizes the expected responses to PPS. This is followed by a detailed comparison of the approach used by ABT Associates versus a very similar method already published by Feder, Hadley, and Zuckerman (1987) at the Urban Institute. Section 4 then offers reasons why the GAIN variable is limited in explaining hospital behavior divided.

2.0 EXPECTED RESPONSES TO PPS

Our research hypothesis using an ex ante GAIN variable is that hospitals expected to be the largest "losers" under PPS should exhibit the largest behavioral reaction to the program. Those expected to break even or even gain under national rates are not expected to change their behavior as much, and any observed change on their part could be attributed to exogenous forces. Potentially big losers under PPS, on the other hand, were hypothesized to respond more quickly and vigorously for two reasons. First, they should run a higher risk of financial insolvency if they do not respond to the pressures of a payment rate below their historical average costs. Second, they are likely to be projected losers in the first place because of technical slack of one sort or another. Stays may be unnecessarily long, too many ancillary services being done on an inpatient versus outpatient basis, or the hospital may simply be incurring overhead and other costs per case above the national average. If their anticipated losses derive from greater slack, then predicted "losers" should have greater latitude and incentive in responding to PPS than a hospital always operating in a technically efficient manner.

Possible responses to PPS should be put in two categories: (1) inpatient cost reducing, and (2) revenue enhancing. Cost-reducing measures would include shorter stays that reduced nursing requirements, elimination of unnecessary ancillaries (e.g., routine chest x-rays on admission), shifting ancillaries to a pre-or post-admission site of care, or simply improving technical efficiency (e.g., letting go marginal workers, negotiating cheaper outside contracts). None of these salutary responses may occur if hospitals choose to emphasize revenue-enhancing activities such as DRG upcoding or alternative revenue sources (e.g., sports medicine clinics, for-profit Durable Medical Equipment and lab services).

3.0 A CONCEPTUAL COMPARISON OF THE PERFORMANCE OF THE GAIN VARIABLE: FEDER VERSUS ABT

To date, success in isolating a PPS effect using a GAIN variable has been mixed. First, there is the work of Feder, Hadley, and Zuckerman (1987) that shows that hospitals predicted to lose the most under PPS had the slowest rate of Medicare cost increase per case from 1982-84, the fastest rate of fall in Medicare lengths of stay, the fastest rate of increase in admissions, a slower rate of decrease in outpatient visits, a bigger reduction in bedsize and FTEs, and the slowest improvement in total margins.

By contrast, the Abt research finds many fewer expected results. Medicare lengths of stay fell faster in "losing" PPS hospitals, but no differences were found for expenses, discharge or occupancy rates, outpatient costs, FTEs, or profits--at least over the first year of PPS.

There are numerous differences in the two studies that could explain such disparate findings. First, Abt Associates compared trends between just two years, the 1982-3 TEFRA year and the 1983-4 PPS year, while the Feder group calculated average rates of change over a two year period, 1982-84.

Second, the sample of Feder hospitals was quite small-particularly for some variables. The Medicare cost per case analysis, for example, was based on slightly over 800 reporting hospitals, divided into roughly equal groups of hospitals only under TEFRA versus both TEFRA and PPS. They were also self-reporting with roughly a 50 percent response rate. Abt's sample includes over 6,200 hospital years, or about 3,000 hospitals in each of the TEFRA and PPS years (although more reported in PPS-1 than TEFRA).

Third, the Feder sample excluded proprietary hospitals. Abt had roughly 500 each year, or one-sixth of the sample.

Fourth, the analytic methods employed by the two groups differed in some important respects. The Feder group had a sample of roughly 400 hospitals each that had either been under TEFRA in both 1982-3 and 1983-4 or had come under PPS in the second year. The Feder group defined PPS participation in terms of a hospital's fiscal year. Where all of a hospital's 1984 fiscal year

was on PPS, it was considered a PPS hospital (i.e., a hospital that started on TEFRA and switched to PPS). This would include only hospitals with fiscal year start dates of October, 1983 and January, 1984. Hospitals with March and July start dates would not have had any time on PPS by the end of their 1984 fiscal year, and hence were considered two-year TEFRA hospitals.

Abt's PPS definition was identical in that they defined TEFRA versus PPS years based on each hospital's own fiscal year. Their sample was different, however, in that all hospitals had both a TEFRA and a PPS year, including the July fiscal year hospitals. Thus, for the large group of July fiscal year hospitals, the Feder group is comparing 1982-83 to 1983-84 while Abt is comparing 1983-84 to 1984-85. For Feder, 1983-84 is a TEFRA end year for these hospitals while for Abt it is a base year. Not only can responses be different over these two periods, the overall rate of inflation could have been different.

Fifth, the two studies never analyze the same cost variable. The Feder group only analyzes Medicare cost per admission while Abt analyzes total expenses per discharge. Medicare cost per discharge is, in a large sense, an accounting approximation to actual costs. It is determined by applying average routine costs per day times the number of Medicare days in the hospital plus Medicare inpatient ancillary charges times the ancillary cost-to-charge ratio. This numerator is then divided by total Medicare discharges. If Medicare's length of stay were falling faster than non-Medicare's LOS, its cost per discharge would fall as well, even if routine cost per day were rising. Suppose routine and ancillary costs were constant from the TEFRA to the PPS year and Medicare and non-Medicare admissions were unchanged. Then, on a cost per discharge basis, no change would occur at the hospital level, and we would conclude that PPS had no effect. But if the Medicare LOS were falling, less of the constant routine costs would be appropriated to Medicare patients, producing a reduction in Medicare cost per case. Thus, the Feder group would show a decline in costs per Medicare discharge for this hospital while Abt would show no change in total costs per discharge. In this extreme example of no change in routine total nursing costs with shorter Medicare stays, the HCFA cost-finding algorithm assumes a

constant average cost (equal to that in the TEFRA year) while it is really zero, i.e., shorter stays, no cost reductions. Therefore, an analysis of Medicare costs is an analysis of the Medicare cost accounting algorithms as much as any PPS-induced changes in hospital cost levels. Another way of looking at it is as an analysis of Medicare's "responsibility" for its "share" of inpatient costs, not what the true reduction in costs actually were.

Abt may also have inadvertantly included outpatient costs in their total inpatient expense figure. This was the result of using total costs of ancillary services as they appear on Worksheet A of the Medicare cost report. These costs include, for example, the costs incurred by ambulatory day patients in the operating room. Over time, ancillary departments have devoted more resources to outpatients. Thus, total ancillary costs have been rising faster than true inpatient ancillary costs. It is the latter figure which is strictly comparable to Feder's Medicare inpatient figure.

It is important to note that both Abt and the Feder group did find PPS effects on Medicare's length of stay with "expected loser" hospitals shortening their stays the most.

Sixth, the Feder group and Abt each use a different specification of the regression equation. The Feder group analyzes the dependent variable in percentage change terms while Abt uses absolute annual levels. Thus, percentage effects are immediately obvious in Feder's work but not in Abt's. Abt deals with this problem by using a dummy for the first PPS year (with its coefficient = $261 in the cost per case regression) then comparing interactions of this dummy with high or low GAIN, holding many other characteristics constant. The signs of the PPS-GAIN interactions are unexpected, with expected gainers showing slower growth in costs. Interestingly, in their descriptive work, Abt does find that expected winning hospitals had a 16.3 percent growth in cost per case versus 10.6 percent among expected losers--although the absolute dollar changes are essentially identical. It is possible that equal absolute increases imply quite different percentage changes if winning-losing is correlated with initial cost per case. Abt, however, includes bedsize and teaching status which should control

quite well for average cost per case. It may be preferable, however, to estimate the equations in percentage terms.

Abt also controls for exogenous variables that the Feder group does not. The Feder group uses dummy variables for region, bedsize, teaching status, and ownership. This specification tests for differences in percentage changes holding hospital characteristics constant. Abt does this as well, but extends the controls to include several demand and supply-side variables, e.g., per capita income, population density, MDs per capita, and a Herfindahl competition index. Most of these variables have strong cross-sectional explanatory power (e.g., per capita income and AFDC percentage each had t statistics of 16, but their time series role is unclear. It is always possible that the Feder groups "losing" hospitals exhibited slower growth because of slower demand growth -- although this seems unlikely. In any event, it seems more rigorous to control for demand-supply changes that could be correlated with expected PPS gains.

Seventh, the Feder group and Abt calculate expected PPS gains in a similar, but not identical, fashion. The general PPS index in both cases were based on the formula:

$$\text{INDEX} = \frac{(\text{PPSPAY} - \text{COST})*\text{MEDVOL}}{\text{HOSPDOL}}$$

where PPSPAY = PPS Payments per case; COST = Medicare inpatient costs; MEDVOL = number of Medicare discharges; and HOSPDOL = projected total hospital revenue. The index is the difference between a expected PPS payment and average cost per case, or GAIN, weighted by Medicare volume then divided by a total hospital dollar base. The following table summarizes the specific definitions of the variables used by the two researchers:

	Feder	Abt
PPSPAY	1984 PPS Average Payment per Case under PPS (75% hospital-specific	1) 1984 PPS Average Payment per Case (75% hospital-specific with additions for IME and outliers to 5% federal amount) 2) Fully implemented PPS Average Payment per Case
Cost	Projected 1984 Medicare Payment per Case under cost reimbursement	1984 Medicare Hospital-specific portion (deflated by 1981 CMI and increased by expected outliers and the 1981-84 PPS update
MEDVOL	Projected 1984 Medicare admissions	Total Medicare inpatient costs divided by total inpatient costs, based on TEFRA cost report
HOSPDOL	Projected 1984 total hospital revenue	Cost, or 1984 PPS hospital-specific costs

Abt calculated both a long-run and a short-run GAIN using fully implemented vs. 1984 PPS payment rates; the Feder group used only the short-term, 1984 rates. Abt relied more on its long-run results assuming that hospitals would begin to change behavior to conform with the rates that would be binding three years hence.

The Feder group projected their own Medicare costs per case using 1980-82 data and a regression equation. Abt used the 1984 hospital-specific portion as a proxy. It is not clear which is a more accurate representation of where hospitals stood costwise on the eve of PPS.

Feder then multiplies the gain(loss) by total projected Medicare admissions and divides by total hospital revenues. Abt multiplies its gain, first, by the share of Medicare in total inpatient costs, then divides by the

hospital's actual 1984 actual total costs. Thus, the Feder group is effectively taking the expected dollar gain per case and multiplying it by the ratio of Medicare admissions to total hospital revenue while Abt uses the ratio of Medicare admissions to total costs as a weight (and assuming Medicare total costs = Medicare hospital-specific cost per case times the number of medicare admissions). This difference in the weighting of the gain per case is unlikely to be significant.

In sum, much or all of the key differences between Feder and Abt could be attributed to the use of different cost measures. Abt, in its preliminary report dated in April of 1987, even notes the large differences reported by Feder in total hospital cost inflation versus Medicare cost increases. The later grew much less in PPS "loser" hospitals, they argue, because LOS fell so much faster. This result Abt also found, but they never analyzed Medicare cost per case.

Large differences in sample sizes and the way in which July, 1984 hospitals were considered also renders the results somewhat incomparable.

4.0 REASONS WHY GAIN MAY FAIL TO PRODUCE EXPECTED RESULTS

There are numerous reasons why a cross-sectional GAIN variable may not successfully identify PPS responses.

First, and most important, all hospitals under PPS have an economic incentive to cut costs, shorten Medicare stays, reduce ancillaries, and shift services to outpatient settings. Expected losers, or course, would appear to be forced to do so or run a perpetual loss, but even potential winners are likely to improve efficiency in order to generate even more profits for other activities. Thus, any PPS GAIN index is measuring the relative improvement in efficiency. It still should be greater in "losing" hospitals, but the difference may not be large enough to be statistically significant. There is even the possibility that lower cost hospitals expected to be winners under PPS have superior cost-saving abilities and inclinations that reveal themselves when profits are to be made.

Closely related to the general profit motive under PPS is the huge uncertainty factor affecting most hospitals. Apparently, most hospital CFOs knew the amounts they were to be paid under PPS, both in 1984 and under a fully implemented system, so this source of uncertainty was not as great as many think. They were more uncertain about what their true Medicare-specific costs were just prior to PPS, what the true Medicare CMI was, and what was going to happen to hospital volumes, outliers, and costs in the ensuing year or two. Most had some data on charges per patient and a few had converted these to average costs, but CFOs knew that these were accounting artifacts to some degree. True costs could be much higher or lower. Given this uncertainty, many assumed that real costs were higher and took precautionary cost-cutting measures.

They were also uncertain about the effects of declining volumes on future costs. If admissions and overall days were to fall drastically, so would revenues from Medicare or other payors. At the same time, average costs per case could rise given the large portion of hospital costs that are fixed. While Medicare payments were now insensitive to shorter stays under PPS, non-Medicare per diem payments generally were not. This worried CFOs and led to a more conservative cost trend than necessarily warranted given their expected Medicare gain alone.

A hospitals's economic risk is also particularly sensitive to long stay patients. A few more outliers could be economically devastating to hospitals. This was particularly true of smaller hospitals, which also tended to be bigger expected winners. Faced with greater outlier risk under PPS, these hospitals may have been more cost conscious than predicted by the expected average Medicare gains alone.

Another reason why expected losers may not have reduced costs relative to expected winners is the former's ability to raise revenues. Greater revenues could be generated within the Medicare program through "DRG Creep," and their is strong evidence that larger, more expensive hospitals enjoyed faster increases in their DRG casemix, and hence, their Medicare billings.

Greater revenues could also come from more outpatient activity. It is very likely that larger, more costly, hospitals were also in a better position

to shift ancillary testing to their own outpatient department. They may also have had the administrative and financial capacity to expand into new outpatient activities like sports medicine, home health, and durable medical equipment.

For whatever reason, hospitals that were able to increase revenues faster had less reason for cutting costs. They could use the expanded services to cover any Medicare shortfalls.

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ISOLATING THE EFFECT OF PPS ON HOSPITAL BEHAVIOR: ANOTHER LOOK AT THE PPS IMPACT INDEX AND ITS USE

Working Paper

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ISOLATING THE EFFECT OF PPS ON HOSPITAL BEHAVIOR: ANOTHER LOOK AT THE PPS IMPACT INDEX AND ITS USE

1. Introduction

The change to a prospective payment system (PPS) for Medicare reimbursement in the mid 1980's coincided with a decline in hospital utilization overall and within the Medicare population. At the same, the tremendous growth in hospital costs started to slow, so that, although costs have continued to grow, they are doing so at less than half their 1980-82 rate. Since the change to PPS was coincident with these changes, there has since been much effort at determining to what extent, if any, these changes were the result of the cost-containment incentives of PPS.

Feder, Hadley and Zuckerman present a statistical analysis of the effect of PPS in their article "How Did Medicare's Prospective Payment System Affect Hospitals?".[1] Unlike the many analyses of trends and descriptive discussions of growth rates, Feder et al. offer a comprehensive, multivariate look at the effect of PPS on hospitals. In particular, they developed a "PPS Impact Index" which captured the hospital-level pressures of PPS, and proved to be a useful tool in analyzing the effects of these pressures.

There are, however, some shortcomings to their data and design. In particular, we have two major concerns about their paper:

- their data were from a special AHA mail survey which had a response rate of 55 percent, raising concerns about self-selection bias, and which was not representative of the short-term, general hospital population;
- their design compared "TEFRA hospitals" and "PPS hospitals" based on which Medicare reimbursement policy each hospital was under in its 1984 fiscal year--however, all hospitals were TEFRA and PPS hospitals at some point so we feel a panel design is much more appropriate.[2]

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[1] New England Journal of Medicine, Vol. 317, No. 14, 1 Oct 87, pp. 867-73.

[2] Because some hospitals may have changed fiscal years to delay or speed up their change to PPS, there could also be some self-selection bias introduced by the design.

The purpose of this paper is to review their analysis and findings and then to try to repeat their work on a much larger, more complete set of data. In the course of retracing their steps, we get some different results, which suggest the need for an alternative estimation technique. The need for the change in estimation raises some questions about the earlier work and findings.

The paper is organized into five sections. Following this introduction is a discussion of the Feder et al. paper, its methods and findings. The third section discusses our data and details the definition of our "GAIN" variable, which is analogous to the PPS Impact Index. The fourth section presents simple descriptive statistics which are consistent with the Feder findings, and then moves on to estimates based on a multivariate model which are not. Alternative interpretations of the model, and finally an alternative estimation method are presented. The failure of ordinary least squares (OLS) to support the Feder and descriptive results and the need for an alternative technique may be an important insight into the use of a GAIN or PPS Impact Index style variable. The fifth and final section includes a discussion of this and other issues raised by the two papers.

2. Review of Previous PPS Analyses Using a "PPS Impact Index"

The major contribution of the Feder, Hadley, and Zuckerman article is the development of the "PPS Impact Index", which can be used to measure the hospital-level impact of PPS. By comparing PPS payments with those under cost-based reimbursement, the index captures those cost-containment incentives faced by each hospital that are attributable to Medicare policy. The index does not attempt to measure what happened under PPS, but rather what would have happened if hospitals did not react to the program.

In their article, Feder, Hadley, and Zuckerman used data from two sources: a special survey done by the American Hospital Association (AHA) of a sample of nonprofit hospitals and the AHA's annual hospital survey. The special survey, which gathered some financial data not available from the AHA annual survey, yielded usable data from a sample 827 hospitals for two years (1982 and 1984). No proprietary hospitals were included in the sample, and the authors state that hospitals with fewer than 100 beds were underrepresented in the sample. The survey was done by mail, and had a response rate of about 55%.

The survey data were used to create a model to project cost-based reimbursement per case. These projections were then used to define the PPS Impact Index:

$$\text{INDEX} = \frac{(\text{PPS} - \text{CB}) * \text{MCRADMS}}{\text{TOTREV}}$$

where PPS is 1984 payment per case under PPS, CB is a hypothetical 1984 payment per case under cost reimbursement, MCRADMS is projected 1984 Medicare admissions, and TOTREV is projected 1984 total hospital revenue. Hospitals with a relatively high index value stand to gain under PPS. Incentives for them to try to become more efficient (shortening stays, laying off staff, reorganizing service delivery) are hypothesized to be less powerful than for hospitals at financial risk under PPS -- those with low index values. If the payment system is on average revenue-neutral, then the average index value should be zero, separating winners with positive values and losers with negaive values.

The PPS effect on hospitals' behavior was measured in two ways. First, a comparison across Medicare payment systems was made by looking at the difference between two groups of hospitals -- those which were paid under PPS in their 1984 fiscal year and those which were paid under TEFRA in FY84. The authors compared 1982-1984 growth rates of admissions, days, cost, revenues, etc. between the TEFRA and PPS groups. Second, the PPS hospitals were subdivided into three subgroups, given by quartile of the PPS Impact Index (quartiles 2 and 3 are left as one group) to look at differences within PPS, across expected PPS impact.

Feder et al. reported similar results from both univariate and multivariate analyses. They found that Medicare costs rose more slowly in PPS hospitals than in TEFRA hospitals, and that those PPS hospitals in the lowest (most adverse PPS impact) quartile had slower cost increases than those in the top quartile. This pattern is repeated for length of stay and FTEs, two measures which are generally thought to be short-run tools for cost containment -- PPS hospitals had larger reductions than TEFRA hospitals and, within PPS hospitals, the lowest quartile had larger reductions than the highest.

Feder et al. use their statistical findings that those hospitals relatively better off under PPS showed less cost-containment behavior to assert that the national rates will generate only "extra profits" and not additional cost containment. They argue that prospective rates based solely on each hospital's costs would create the desired cost containment incentives without allowing for any windfalls.

The authors discuss TEFRA's role as an intermediate step between cost-based reimbursement and PPS. Under TEFRA, a target cost per case was established for each hospital. Hospitals with costs below target could keep half of the difference up to 5 percent of the target, while those with costs over target were reimbursed 25 percent of the difference. So, like PPS, hospitals could win or lose per case under TEFRA but, unlike PPS, these gains or losses were constrained. TEFRA was also based on a predetermined cost per case for each hospital, but these figures were based solely on each hospital's own experience while under PPS, after a phase-in period when rates are derived from each hospital's costs and national costs, they are tied to national averages. The authors write that similar growth in revenues for TEFRA and PPS hospitals reflects the revenue constraints in place under both.

However, it is because TEFRA is indeed a bridge between cost-based reimbursement and PPS that we feel that this article has a flawed design. To some extent, Feder et al. are comparing apples and oranges in their attempt to attribute behavior to PPS. The division of hospitals into TEFRA and PPS groups is also a division of hospitals into two groups with other differences: one which, between 1982 and 1984, was under cost-based reimbursement for two years and TEFRA for one and a group which was under each regime (cost-based, TEFRA, PPS) for one year. It would be surprising to discover that hospital behavior under two years of cost-based reimbursement was not different from two years of revenue-constrained reimbursement. All short-term general hospitals in non-waivered states went from cost-based to TEFRA to PPS reimbursements. Therefore, it may be more appropriate to consider each payment regime as states through which each hospital passes. In this framework, we can compare all hospitals' response to PPS with their behavior under TEFRA.

3. Data and GAIN Variable Measurement

Because it seems more appropriate to consider the PPS effect as being the effect on each hospital of going from TEFRA to PPS, we adopted a panel design, using data from both payment systems for each hospital. Using data from Medicare Cost Reports (MCR), the AHA annual survey, and a file of PPS-related variables from HCFA, we have constructed a data set of TEFRA and PPS data for nearly 4,000 hospitals.[3]

To capture the hospital-level view of PPS, we define two variables: one, similar to the PPS Impact Index, to capture hospital-level effects:

$$\text{GAIN} = \text{Medicare dependence} * \frac{\text{PPS payment - cost}}{\text{cost}}$$

and a PPS dummy variable, to capture industry-wide effects. Like the PPS impact index described above, high values of GAIN are associated with relatively better positions under PPS.[4] GAIN can be thought of as capturing each hospital's expected financial gain (not necessarily positive) under the system based on net revenue per Medicare discharge and overall Medicare dependence. Medicare dependence is given by the Medicare inpatient cost percent of total costs. Since we hope to capture a hospital manager's perspective of PPS pressures on the eve of PPS, we will use actual TEFRA year costs both to calculate PPS payments and to measure the gap between payments and costs. An alternative to TEFRA costs is the hospital-specific portion (HSP), a projected value based on 1982 costs assigned to each hospital and actually used by HCFA to calculate payments. The projected cost-based reimbursement used by Feder et al. is very similar to HSP.

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[3] MCR extracts are available for the year preceding TEFRA, the base year, but it was found that many key variables were missing from these extracts and that there were many missing values among those variables included. Therefore, we limit ourselves simply to the two years of data. Analytically, this may cause us to lose the ability to detect any anticipatory changes made before the change to PPS. This will lead us to understate the effect of PPS, since the TEFRA data may already include any such anticipation.

[4] GAIN is algebraically identical to the PPS index defined above.

Although a manager may have known the gist of the payment formula, it seems unlikely that she would have known the exact HSP which, as described by HCFA staff, would have been developed by her intermediary from her 1982 cost report and "supplemental information" and then updated to coincide with her PPS start date. Therefore, as she is pondering her strategy under the new system, it seems more likely for her to use her known TEFRA costs in her calculations. Since they should be near substitutes, the correlation between the TEFRA costs per discharge and HSP should be quite high; in fact, these data show a lower than expected correlation at 0.80.[5]

A PPS dummy is created to mark the PPS year data. The GAIN variable is set to 0 in the TEFRA year and the value as calculated above in the PPS year, so that it will pick up any changes in the PPS year which are different across GAIN values. Following Feder et al., the value of GAIN is then converted to quartiles which are used to create two dummy variables, one each for the lowest and highest quartiles. The hospitals in the lowest quartile are those which would a priori appear to be relatively more constrained under PPS, while those in the highest quartile are those which are less contrained by PPS.

---

[5] We also created an alternative GAIN variable using HSP, which had a correlation of 0.69 with our GAIN variable using TEFRA costs. The importance of these differences and the effect on GAIN and its use may be an important area of further research.

Most of the analysis variables used below -- lengths of stay, costs per case, liquidity, and margins -- are computed from data in the MCRs, while FTEs are computed from the AHA surveys. Definitions are given for the analysis variables in Exhibit 1. The stratifiers -- urban/rural bedsize, type of control, teaching status, and region -- use information from all three sources, and are defined as of the first PPS year. The two cost variables, inpatient cost per discharge and expense per adjusted discharge, are both deflated by 4% in the PPS year, to control for the overall rate of inflation at that time.

4. Using GAIN to Understand PPS's Effect on Hospitals

Armed with our GAIN variable, we will now turn to analyzing PPS's effect on hospitals. As mentioned above, short term responses to the new reimbursement scheme are expected to show up in output and labor -- for example, length of stay and FTEs -- while longer-term responses might affect capital investments such as more efficient heating/air conditioning systems, computerization of medical records, and adaptation of existing physical plant to alternative uses such as outpatient surgery. Since we are using only data from the first year of PPS, we will focus primarily on those measures which are most likely to change in the short run. For simplicity, we will begin our analysis by looking only at total length of stay, but will later consider several other important variables.

Among the hospitals in our sample, total length of stay fell from an average of 6.1 days in TEFRA to an average of 5.5 days in PPS, a statistically significant drop of 10 percent (t-value = -16.42).[6] Those hospitals in the top GAIN quartile had a 7 percent drop, while those in the bottom quartile had a 12.6 percent drop. This is similar to the pattern reported by Feder et al. for both Medicare and non-Medicare lengths of stay. Abt

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[6] HCFA reports a 9.0 percent decline in Medicare length of stay in FY84, after a decade of 1 to 3 percent annual declines.

Exhibit 1

Analytic Variable Definitions

Variable	Definition
Length of Stay	Total inpatient days/total discharges
Medicare length of stay	Medicare inpatient days/Medicare discharges
Inpatient cost per discharge	Total direct inpatient cost/total discharges[1]
Expense per adjusted discharge	Total expense/(total discharges * (total patient revenue/total inpatient revenue))[1]
Liquidity	Current assets/current liabilities
Operating margin	(Net patient revenues - operating expenses)/net patient revenues
Full-time equivalent staff	Full-time staff + .5 * part-time staff
Total margin	(Total revenue - total expenses)/total revenue

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[1] PPS year value deflated by 4 percent.

Associates Inc. (AAI) has similar findings;[7] they report a 12 percent drop for the bottom group and 7 percent for the top. (In this earlier study, AAI used a GAIN variable based on the HSP rather than actual TEFRA costs.) AAI also presents evidence of differential responses across other stratifiers -- for example, small rural hospitals only experienced a 4.8 percent decline in length of stay while large urbans dropped nearly 14 percent. These differences in other stratifiers suggest that a more comprehensive, multivariate approach may be important for isolating the PPS and GAIN effects.

Feder et al. state that all of their descriptive statistics are supported by similar results estimated in regressions which control for hospital attributes such as urban/rural location, bedsize, region, control, and teaching status. We estimated a similar model with ordinary least squares (OLS), including a PPS dummy and the two GAIN dummies -- LOW and HIGH, for the low and high quartiles. The PPS dummy should capture the overall average difference between the two years (in the case of length of stay a drop, so one would expect negative coefficient), and the two GAIN dummies should capture the differential PPS effect for the two quartiles. According to the descriptive statistics reported above, we should find that the LOW coefficient is negative, leading to a larger than average drop in length of stay for the hospitals at greatest fiancial risk under PPS. The HIGH coefficient may be of any sign, but, if negative, should not be as large as the LOW coefficient. A negative sign on HIGH would suggest that the two middle quartiles experienced smaller drops in length of stay than either of the extreme groups. However, Feder et al. find that the change in length of stay is progressively larger in magnitude across the quartiles from HIGH to LOW, so we would expect a positive estimate for the HIGH variable.

The results of the OLS estimation are shown in Exhibit 2. The PPS coefficient is significantly negative, as expected. However, the GAIN quartiles are opposite their

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[7] "The Impact of PPS on Hospital Costs, Efficiency, and Financial Viability: Year 1 Report," Report to HCFA, May 8, 1987.

Exhibit 2

OLS Estimates of Length of Stay Model[1]

Dependent Variable: Total Length of Stay

	Estimate	t-Value
Intercept	6.58	96.10
HIGH	-0.15	-2.71
LOW	0.44	8.23
PPS	-0.67	-17.60

R^2 0.2753

N 7872

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[1] Complete model estimates are shown in Appendix; variables not shown here include dummies for region, urban/rural bedsize, type of control, and teaching status.

expected effects. The significant positive estimate for LOW and the significant negative estimate for HIGH, according to the expected interpretation, suggests that those hospitals which would expect to be better off under PPS experienced relatively LARGER drops in length of stay, while those under stronger cost pressures had smaller changes. (To calculate the complete PPS/HIGH and PPS/LOW effects, we must add together the PPS and HIGH (or LOW) coefficient estimates. Therefore, the LOW group has an average drop in length of stay of (-0.67+0.44=) 0.23 days, while the HIGH group drop is (-0.67-0.15=) 0.82 days.)

There is an alternative explanation of these results which in turn suggests an alternative method of estimating the model. To the extent that PPS incentives are coincident with efficient/cost-minimizing behavior, big GAINers may have been acting in desired, efficient ways before PPS was instituted, and may continue to show gains after the beginning of PPS as they continue their same behavior. In other words, the HIGH group may exhibit behavior consistent with PPS incentives because that is the behavior that led them to be big GAINers. Therefore, the GAIN variable may be highly correlated with hospital attributes such as "effective management" which we cannot measure. If it were measurable, the "good manager" variable could be an important explanatory variable. The large difference in length of stay in the TEFRA year between the highest and lowest GAIN quartiles suggests that the two groups were indeed quite different -- the average length of stay among the bottom quartile was 6.8 days, nearly one and a half days higher than the top quartile average of 5.5 days.

If it is the case that there is an omitted hospital-level variable such as "good manager", then the errors of the estimated model will be highly correlated with any explanatory variable which is correlated with the omitted variable. If, in this case, GAIN is correlated with an important omitted hospital-level variable, then the coefficient estimates are biased and inconsistent.

We can, however, estimate the model of length of stay with a method which removes such hospital-level effects. In particular, fixed-effects estimation should correct for omitted hospital-level variables. With only two years of data, representing all varables as first differences rather than levels should net out all hospital-invariant effects. We assume that the omitted effects, such as "good manager", do not change between the two years, so that their influence is eliminated when we take first differences. Effectively, this allows only the hospital-level attributes which changed between the two years to explain the change in the dependent variable. We now have only one observation per hospital, which is given by the PPS value of each variable minus its TEFRA value. Since all the explanatory variables except HIGH, LOW, and PPS are equal in both years, the alternative estimates will include only three variables regressed against the first difference of length of stay. Presumably, hospital effects are now completely controlled for, and we should get the expected positive coefficient for GAIN.

The fixed-effects coefficient estimates are shown in Exhibit 3. The PPS estimate remains significantly negative (and is similar to the levels estimate in magnitude), but the GAIN dummies now have their expected signs. The dramatic differences in the two sets of estimates suggest that there may indeed have been important hospital attributes omitted from the levels equation.

To confirm the above results, we estimated the same pair of regressions on seven other major analysis variables: Medicare length of stay, inpatient cost per discharge, total expense per adjusted discharge, liquidity, operating and total margins, and FTEs. Before presenting those results, however, it is important first to establish the expected signs for the PPS, HIGH, and LOW dummies for each analysis variable.

Assuming that PPS generates incentives for hospitals to control costs, we would expect the first three measures (length of stay and the two cost per case measures) and FTEs to decline under PPS, yielding a negative coefficient for PPS. (A negative PPS coefficient is actually unlikely for the two cost measures -- nominal costs are not expected to decline but to rise more slowly. Since the PPS year costs were deflated by the overall rate of inflation, 4%, a positive coefficient on the PPS dummy indicates that inflation in medical costs is still higher than the overall rate, which would be expected.)

Exhibit 3

Fixed-Effects Estimates of Length of Stay Model

Dependent Variable: Total Length of Stay

	Estimate	t-Value	
HIGH		0.18	3.25
LOW	-0.29	-5.16	
PPS	-0.57	-17.67	

R^2	0.0136
N	3936

Low GAINers, presumably under more cost-containment pressure, should decline more than high GAINers, which should translate into a negative sign on LOW and positive on HIGH. (Like total length of stay, the positive HIGH coefficient really translates to a smaller decline rather than an increase.)

The three financial variables, liquidity and the two margins, are tied partly to revenues and are likely to work the other way: hospitals would want them to improve under PPS with their cost-containment efforts, and so the PPS effect should be positive and the GAIN effects reversed, with LOW having a larger positive effect than HIGH. (Expectations for these estimates are weaker than those for length of stay and FTEs. A manager's ability to manipulate revenues is uncertain, compared to his managerial authority in allocating hospital resources. Therefore, hospitals may actually hope that their cost-containment efforts will improve their financial standing without knowing that they will actually improve over TEFRA year figures.)

The results of the fourteen models are shown in Exhibit 4. The top half shows the original OLS levels estimates. The HIGH and LOW estimates are exactly opposite their expected sign in all but the total margin model, where both are insignificant. However, the fixed effects estimates results are somewhat closer to expected, with many HIGH and LOW effects becoming insignificant. Both Medicare length of stay and FTEs have the expected HIGH/LOW pattern, with significant negative coefficient for the LOW group and a significant positive value for the HIGH group. Both Medicare length of stay and FTEs have a significantly higher mean for the LOW group in the TEFRA year, so for comparison to Feder et al., we can convert to percent changes, shown in Exhibit 5: in Medicare length of stay, the LOW group has a total PPS/LOW effect of -1.55 days, a 17 percent drop from their TEFRA mean, while the HIGH group has a total PPS/HIGH effect of -1.01 days, a 14 percent drop from their TEFRA mean. Feder et al. report a similar change for the LOW group but a smaller decline for the HIGH group -- their two-year changes (1982-84) are 17.5 percent for the LOW group and 11.1 percent for the HIGH.

Exhibit 4

OLS and Fixed-Effects Estimates of Seven Additional Measures[1]

(t-values in parentheses)

	Medicare Length of Stay	Inpatient Cost per Discharge	Expense per Adjusted Discharge	Liquidity	Operating Margin	Total Full-Time Equivalent Staff	Total Margin
				Levels[1]			
Intercept	9.47	2710.24	2669.57	2.26	-0.02	395.86	0.20
	(150.60)	(58.33)	(50.04)	(36.88)	(-2.86)	(32.64)	(29.49)
HIGH	-0.41	-524.40	-418.85	0.20	0.02	-32.00	-0.00
	(-8.15)	(-14.11)	(-9.82)	(4.07)	(2.85)	(-3.27)	(-0.04)
LOW	0.53	541.85	619.39	-0.09	-0.02	7.46	-0.01
	(10.69)	(14.83)	(14.29)	(-1.96)	(-3.28)	(0.78)	(-1.63)
PPS	-1.27	307.62	52.25	0.08	0.04	-6.95	-0.02
	(-36.64)	(11.97)	(1.76)	(2.48)	(8.32)	(-1.04)	(-4.20)
R^2	0.5582	0.3925	0.3416	0.0406	0.1399	0.8435	0.1847
N	7876	7872	6476	4972	6478	7740	6608
				Differences			
HIGH	0.19	-40.35	33.39	0.04	-0.01	5.02	-0.02
	(4.41)	(-1.17)	(0.89)	(0.81)	(-0.97)	(1.76)	(-3.40)
LOW	-0.35	44.00	-1.85	0.02	-0.00	-8.33	-0.00
	(-8.24)	(1.28)	(-0.05)	(0.51)	(-0.10)	(-2.74)	(-0.29)
PPS	-1.20	310.68	79.56	0.09	0.04	-12.03	-0.01
	(-48.66)	(15.68)	(3.67)	(3.76)	(9.18)	(-7.37)	(-4.18)
R^2	0.0309	0.0011	0.0003	0.0003	0.0003	0.0044	.0034
N	3938	3936	3238	2486	3239	3870	3304

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[1] Complete model estimates are shown in Appendix; variables not shown here include dummies for region, urban/rural bedsize, type of control, and teaching status.

Exhibit 5

TEFRA Means and Combined Coefficient Estimates as Percent of Means

	Length of Stay	Medicare Length of Stay	Inpatient Cost per Discharge	Expense per Adj. Discharge	Liquidity	Operating Margin	FTE	Total Margin
TEFRA Mean	6.10	8.21	2379.73	2411.64	2.27	-0.01	460.20	0.20
High Group	5.48	7.17	1704.91	1730.56	2.43	-0.01	222.45	0.19
Low Group	6.79	9.15	2970.49	3084.03	2.15	-0.02	591.43	0.20
PPS/HIGH[1]	-0.39	-1.01	270.33*	112.95*	0.13*	0.03*	-7.01	-0.03
as % of TEFRA[2]	-7.1	-14.1	15.9	6.5	5.4	n.a.[5]	-3.2	-15.8
PPS/LOW[3]	-0.86	-1.55	354.68*	77.71*	0.11*	0.04*	-20.36	-0.01*
as % of TEFRA[4]	-12.7	-16.9	11.9	2.5	5.1	n.a.[5]	-3.4	-5.0

*HIGH or LOW coefficient not significantly different from zero at 10 percent level.

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[1] Sum of PPS and HIGH fixed-effects estimates shown in Table 2 and bottom half of Table 3.
[2] PPS/HIGH as percent of HIGH TEFRA mean.
[3] Sum of PPS and LOW fixed-effects estimates shown in Table 2 and bottom half of Table 3.
[4] PPS/LOW as percent of LOW TEFRA mean.
[5] Cannot calculate percent change of negative mean.

We get estimates in the inpatient cost per discharge model different from expected, and opposite those suggested by Feder et al. (Their most comparable results are for Medicare cost per case, which should be virtually the same as the variable used here.) We find that the HIGH group has a significantly lower increase in inpatient costs per case than the average, while the LOW group is significantly higher. However, as Exhibit 5 shows, converting the coefficients to total PPS/HIGH and PPS/LOW effects and comparing them with the TEFRA year mean for each group tells a slightly different story. The dollar difference for the LOW group is (67.37+420=) 487.37, while the HIGH group difference is (-70.63+420=) 349.39. Converting these difference to percent of TEFRA year means shows that cost per discharge grew 16 percent for LOW and 20 percent for HIGH hospitals. Feder et al. report Medicare cost per case growing three times faster for the high group compared to the low (10 percent compared to 3 percent) between 1982 and 1984.

Three variables, expense per adjusted discharge, liquidity, and operating margin, show only significant PPS effects, with no difference among GAIN groups. Total margin, although with unexpected sign, shows the expected pattern of a higher effect for the LOW group relative to the HIGH group -- in this case it appears as a significant decline for the HIGH group compared to no significant effect for the LOW group. This effect is exactly opposite that reported by Feder et al., who find a progressive improvement in total margin from low to high PPS index quartiles.

The PPS coefficients in each pair of estimates are very similar, except for the FTE equation. This is not surprising, since hospitals use FTEs and beds in relatively fixed proportions. Therefore, the urban/rural bedsize dummies on the right side of the levels regression create a virtual identity, and mask the separate effects of PPS and GAIN variables, as evidenced by their huge standard errors. (The PPS standard error is 6.7 in the levels equation, compared to 1.6 in the differences equation, despite the fact that the differences' estimate is twice the size of the levels' and the sample is half the size.) The FTE coefficients in the difference equation yield a combined PPS/LOW effect of a

20.36 drop compared to a PPS/HIGH effect of a drop 7.01 -- however, both convert to 3 percent drops from each group's TEFRA mean.

5. Discussion

We have used GAIN, like Feder et al.'s PPS index, to try to capture the differential effect of PPS across hospitals. Because the goal of the exercise is to isolate the PPS effect, we must consider why we were unable to achieve logical estimates with OLS. In particular, if GAIN is not simply capturing the pressures of PPS on individual hospitals but is also capturing some other hospital attribute, then we must be very careful in interpreting its role in these models. There does indeed seem to be an important hospital-level characteristic which has been previously overlooked, creating the need for a fixed-effects method of estimation. Because the GAIN effect changed so dramatically between the two methods, it seems likely that the GAIN variable is indeed correlated to the omitted variable(s). Therefore, it seems very important to consider exactly what the GAIN variable (or its PPS Impact Index predecessor) is capturing. To the extent that it may be capturing pre-PPS behavior which is consistent with the efficiency, cost-containment goals of PPS, it is very important to differentiate between this extant behavior and newly-placed PPS incentives.

Feder, Hadley, and Zuckerman use the smaller percent changes in cost-containment-related variables such as length of stay and FTEs among the HIGH group compared to the LOW group as evidence that once hospitals can earn a profit, the less constrained group will no longer bother with cost saving behavior. However, at some point, levels matter, and the HIGH group is, in many variables, at significantly different levels on the eve of PPS from the LOW group. For example, the TEFRA Medicare lengths of stay for the two groups differ by two days -- 7.2 days for the HIGH group and 9.2 for the LOW. If inpatient admissions are medically appropriate, it seems that there are lengths of stay below which it is medically undesirable to fall. It also seems likely that one approaches that lower bound asymptotically, so that marginal declines are harder to come by the closer one is to the bound. Therefore, it seems unlikely that a hospital with a 7 day average length of stay will experience the same percent decline as one with a 9 day average length of stay.

Before deciding that the 7 day hospital SHOULD have a length of stay declining at the same rate as the 9 day hospital, we should better understand why the GAIN variable (or PPS Index) led to groups with such different means. This should be an important area for future research.

Further, since our GAIN variable is meant to capture a hospital's view of PPS relative to itself, we think that the stronger response by those at the bottom is consistent with the PPS incentives.Those hospitals which think that they will be worse off under PPS (the LOW group) will react more quickly to better their situation. However, Feder et al. argue that "(s)ince the hospitals in the lowest quartile received the least generous rate but engaged in the greatest degree of cost control, it follows that paying the other hospitals less relative to base-year cost would not have reduced their cost-containment efforts." In other words, they are saying that since those hospitals which would have been worse off under PPS (the LOW group) had the strongest response in cost-containment behavior there is no reason to allow hospitals to be better off (the HIGH group). However, it seems that this would logically extend to say that those who, a priori, saw themselves to be relatively well off under PPS, ie. the big GAINers, would not bother with any cost containment measures. (Our GAIN variable passes through 0 in the second quartile, so that our bottom quartile includes only hospitals which stood to have PPS payments less than TEFRA costs, while the top quartile includes only hospitals which would have improved over TEFRA.) This would translate in our fixed-effects models to HIGH coefficient estimates which were equal in size and opposite in sign to the PPS effect, yielding no change between TEFRA and PPS for the HIGH group. However, the hypothesis that the HIGH and PPS estimates are equal and opposite can be rejected at the 0.0001 level of significance for each of the eight models. This suggests that those hospitals in the HIGH group did indeed change between TEFRA and PPS. Therefore, the least vulnerable hospitals are not as oblivious to the PPS cost-containment incentives as Feder et al. suggest.

Appendix

Complete OLS Model Estimates

(referred to in Exhibits 2 and 4)

```
DEP VARIABLE: HLOS      TOTAL LOS

                         SUM OF            MEAN
SOURCE      DF          SQUARES          SQUARE          F VALUE          PROB>F

MODEL       24         5588.240         232.843          124.187          0.0001
ERROR     7847        14712.631        1.874937
C TOTAL   7871        20300.871

     ROOT MSE          1.369283        R-SQUARE           0.2753
     DEP MEAN          5.799585        ADJ R-SQ           0.2731
     C.V.              23.61002

                      PARAMETER        STANDARD     T FOR HO:                            VARIABLE
VARIABLE    DF         ESTIMATE           ERROR   PARAMETER=O     PROB > |T|               LABEL

INTERCEP     1         6.578836        0.068456        96.104         0.0001    INTERCEPT
PPSTOP       1        -0.148460        0.054752        -2.712         0.0067
PPSBOT       1         0.442681        0.053817         8.226         0.0001
PPS          1        -0.666026        0.037849       -17.597         0.0001
BED1         1        -0.770805        0.059783       -12.893         0.0001    RURAL <50
BED2         1        -0.805086        0.061001       -13.198         0.0001    RURAL 50-99
BED3         1        -0.550965        0.070657        -7.798         0.0001    RURAL 100-169
BED4         1        -0.149010        0.090577        -1.645         0.1000    RURAL >169
BED5         1        -0.414830        0.063848        -6.497         0.0001    URBAN <100
BED6         1         0.396332        0.066186         5.988         0.0001    URBAN 200-299
BED7         1         0.366470        0.078804         4.650         0.0001    RUBAN 300-404
BED8         1         0.425940        0.101218         4.208         0.0001    URBAN 404-504
BED9         1         0.820747        0.107577         7.629         0.0001    URBAN >504
REG1         1        -0.068124        0.120327        -0.566         0.5713    NEW ENGLAND
REG2         1         0.280958        0.081203         3.460         0.0005    MID ATLANTIC
REG3         1         0.025783        0.055746         0.462         0.6437    S. ATLANTIC
REG5         1        -0.099237        0.065132        -1.524         0.1276    E. S. CENTRAL
REG6         1        -0.118823        0.055349        -2.147         0.0318    W. N. CENTRAL
REG7         1        -0.522872        0.055907        -9.353         0.0001    W. S. CENTRAL
REG8         1        -1.272088        0.074712       -17.027         0.0001    MTN
REG9         1        -1.021714        0.058663       -17.417         0.0001    PACIFIC
CONTROL1     1         0.141265        0.038765         3.644         0.0003    PROPRIETARY
CONTROL2     1         0.171999        0.053041         3.243         0.0012    NONFED GOVT
TEACH1       1         0.266350        0.055968         4.759         0.0001    OTHER TEACHING HOSP
TEACH2       1         0.568120        0.121486         4.676         0.0001    MAJOR TEACHING HOSP
```

```
DEP VARIABLE: HMLOS    TOTAL MEDICARE LOS

                      SUM OF          MEAN
SOURCE      DF       SQUARES        SQUARE       F VALUE          PROB>F

MODEL       24     15670.360       652.932       413.265          0.0001
ERROR     7851     12404.073      1.579935
C TOTAL   7875     28074.433

    ROOT MSE        1.256955      R-SQUARE        0.5582
    DEP MEAN        7.586215      ADJ R-SQ        0.5568
    C.V.            16.56893

                     PARAMETER      STANDARD    T FOR HO:                        VARIABLE
VARIABLE    DF        ESTIMATE         ERROR  PARAMETER=0     PROB > |T|          LABEL

INTERCEP     1        9.467370      0.062866      150.595         0.0001   INTERCEPT
PPSTOP       1       -0.409676      0.050258       -8.151         0.0001
PPSBOT       1        0.527324      0.049337       10.688         0.0001
PPS          1       -1.273887      0.034765      -36.643         0.0001
BED1         1       -1.788880      0.054807      -32.640         0.0001   RURAL <50
BED2         1       -1.360211      0.055993      -24.292         0.0001   RURAL 50-99
BED3         1       -0.783512      0.064858      -12.080         0.0001   RURAL 100-169
BED4         1       -0.350862      0.083511       -4.201         0.0001   RURAL >169
BED5         1       -0.878879      0.058552      -15.010         0.0001   URBAN <100
BED6         1        0.374089      0.060687        6.164         0.0001   URBAN 200-299
BED7         1        0.410388      0.072214        5.683         0.0001   RUBAN 300-404
BED8         1        0.701602      0.093220        7.526         0.0001   URBAN 404-504
BED9         1        0.882562      0.099428        8.876         0.0001   URBAN >504
REG1         1        0.010625      0.110460        0.096         0.9234   NEW ENGLAND
REG2         1        0.131318      0.074541        1.762         0.0782   MID ATLANTIC
REG3         1       -0.264404      0.051157       -5.169         0.0001   S. ATLANTIC
REG5         1       -0.364740      0.059716       -6.108         0.0001   E. S. CENTRAL
REG6         1       -0.749722      0.050791      -14.761         0.0001   W. N. CENTRAL
REG7         1       -0.817382      0.051321      -15.927         0.0001   W. S. CENTRAL
REG8         1       -1.547900      0.068704      -22.530         0.0001   MTN
REG9         1       -1.718741      0.053791      -31.952         0.0001   PACIFIC
CONTROL1     1        0.080571      0.035619        2.262         0.0237   PROPRIETARY
CONTROL2     1        0.024670      0.048587        0.508         0.6116   NONFED GOVT
TEACH1       1        0.398439      0.051330        7.762         0.0001   OTHER TEACHING HOSP
TEACH2       1        0.900770      0.110657        8.140         0.0001   MAJOR TEACHING HOSP
```

```
DEP VARIABLE: HIHD      INPATIENT COST PER DISCHARGE

                        SUM OF          MEAN
SOURCE      DF         SQUARES        SQUARE         F VALUE         PROB>F

MODEL       24      4379170546     182465439         211.216         0.0001
ERROR     7847      6778884036        863882
C TOTAL   7871     11158054582

     ROOT MSE          929.453      R-SQUARE          0.3925
     DEP MEAN         2533.464      ADJ R-SQ          0.3906
     C.V.             36.68703

                     PARAMETER      STANDARD     T FOR HO:                              VARIABLE
VARIABLE    DF        ESTIMATE         ERROR   PARAMETER=0     PROB > |T|                 LABEL

INTERCEP     1        2710.242     46.466893        58.326         0.0001   INTERCEPT
PPSTOP       1        -524.403     37.164707       -14.110         0.0001
PPSBOT       1         541.846     36.530103        14.833         0.0001
PPS          1         307.618     25.691152        11.974         0.0001
BED1         1        -417.316     40.580187       -10.284         0.0001   RURAL <50
BED2         1        -660.637     41.406657       -15.955         0.0001   RURAL 50-99
BED3         1        -634.691     47.961045       -13.233         0.0001   RURAL 100-169
BED4         1        -494.049     61.482394        -8.036         0.0001   RURAL >169
BED5         1        -103.112     43.339369        -2.379         0.0174   URBAN <100
BED6         1         158.284     44.926523         3.523         0.0004   URBAN 200-299
BED7         1         168.686     53.491000         3.154         0.0016   RUBAN 300-404
BED8         1         315.612     68.705559         4.594         0.0001   URBAN 404-504
BED9         1         493.478     73.022096         6.758         0.0001   URBAN >504
REG1         1        -409.958     81.676751        -5.019         0.0001   NEW ENGLAND
REG2         1         161.676     55.119496         2.933         0.0034   MID ATLANTIC
REG3         1        -359.986     37.839901        -9.513         0.0001   S. ATLANTIC
REG5         1        -784.161     44.211130       -17.737         0.0001   E. S. CENTRAL
REG6         1        -114.213     37.570150        -3.040         0.0024   W. N. CENTRAL
REG7         1        -654.718     37.949123       -17.253         0.0001   W. S. CENTRAL
REG8         1        -194.021     50.713638        -3.826         0.0001   MTN
REG9         1         274.351     39.819977         6.890         0.0001   PACIFIC
CONTROL1     1       28.466530     26.313011         1.082         0.2794   PROPRIETARY
CONTROL2     1         325.280     36.003277         9.035         0.0001   NONFED GOVT
TEACH1       1         321.729     37.990182         8.469         0.0001   OTHER TEACHING HOSP
TEACH2       1        1835.918     82.463476        22.263         0.0001   MAJOR TEACHING HOSP
```

```
DEP VARIABLE: TEHD_A   TOT EXPENSE PER ADJ DISCH(A)

                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE       PROB>F

MODEL       24   3205895804     133578992       139.464       0.0001
ERROR     6451   6178806636        957806
C TOTAL   6475   9384702440

     ROOT MSE      978.676      R-SQUARE        0.3416
     DEP MEAN     2425.312      ADJ R-SQ        0.3392
     C.V.         40.35257

                  PARAMETER      STANDARD    T FOR HO:                           VARIABLE
VARIABLE   DF      ESTIMATE         ERROR  PARAMETER=0    PROB > |T|               LABEL

INTERCEP    1      2669.568     53.346823       50.042        0.0001   INTERCEPT
PPSTOP      1      -418.851     42.643104       -9.822        0.0001
PPSBOT      1       619.394     43.347584       14.289        0.0001
PPS         1     52.248950     29.626469        1.764        0.0778
BED1        1      -523.998     47.330823      -11.071        0.0001   RURAL <50
BED2        1      -730.492     48.187435      -15.159        0.0001   RURAL 50-99
BED3        1      -675.087     55.477254      -12.169        0.0001   RURAL 100-169
BED4        1      -577.178     69.377620       -8.319        0.0001   RURAL >169
BED5        1      -182.812     51.785848       -3.530        0.0004   URBAN <100
BED6        1       201.780     52.848944        3.818        0.0001   URBAN 200-299
BED7        1       179.964     63.556620        2.832        0.0046   RUBAN 300-404
BED8        1       248.870     80.498551        3.092        0.0020   URBAN 404-504
BED9        1       400.913     85.097473        4.711        0.0001   URBAN >504
REG1        1    -86.702465       122.042       -0.710        0.4775   NEW ENGLAND
REG2        1     87.744064     59.621732        1.472        0.1412   MID ATLANTIC
REG3        1      -233.843     41.653966       -5.614        0.0001   S. ATLANTIC
REG5        1      -516.404     54.329467       -9.505        0.0001   E. S. CENTRAL
REG6        1    -75.234159     41.060875       -1.832        0.0670   W. N. CENTRAL
REG7        1      -504.234     42.596808      -11.837        0.0001   W. S. CENTRAL
REG8        1    -45.516912     62.249318       -0.731        0.4647   MTN
REG9        1       369.292     51.443367        7.179        0.0001   PACIFIC
CONTROL1    1     42.580396     30.501027        1.396        0.1628   PROPRIETARY
CONTROL2    1       413.327     43.020213        9.608        0.0001   NONFED GOVT
TEACH1      1       427.910     45.585675        9.387        0.0001   OTHER TEACHING HOSP
TEACH2      1      1718.005       103.010       16.678        0.0001   MAJOR TEACHING HOSP
```

```
DEP VARIABLE: LIQ      LIQUIDITY

                      SUM OF          MEAN
SOURCE      DF       SQUARES        SQUARE       F VALUE       PROB>F

MODEL       24       192.315      8.013118         8.723       0.0001
ERROR     4947      4544.657      0.918669
C TOTAL   4971      4736.972

     ROOT MSE       0.958472      R-SQUARE        0.0406
     DEP MEAN       2.264318      ADJ R-SQ        0.0359
     C.V.           42.32941

                   PARAMETER      STANDARD    T FOR HO:                       VARIABLE
VARIABLE    DF      ESTIMATE         ERROR  PARAMETER=0    PROB > |T|           LABEL

INTERCEP     1      2.259447      0.061270        36.877       0.0001   INTERCEPT
PPSTOP       1      0.197718      0.048575         4.070       0.0001
PPSBOT       1     -0.094246      0.048154        -1.957       0.0504
PPS          1      0.081280      0.032782         2.479       0.0132
BED1         1     -0.027374      0.054833        -0.499       0.6176   RURAL <50
BED2         1      0.121280      0.055727         2.176       0.0296   RURAL 50-99
BED3         1      0.275957      0.064539         4.276       0.0001   RURAL 100-169
BED4         1      0.265389      0.075862         3.498       0.0005   RURAL >169
BED5         1     -0.072267      0.061695        -1.171       0.2415   URBAN <100
BED6         1      0.013547      0.061231         0.221       0.8249   URBAN 200-299
BED7         1   0.002496335      0.070714         0.035       0.9718   RUBAN 300-404
BED8         1      0.174604      0.086541         2.018       0.0437   URBAN 404-504
BED9         1      0.137102      0.088903         1.542       0.1231   URBAN >504
REG1         1     -0.108152      0.097232        -1.112       0.2661   NEW ENGLAND
REG2         1      0.073074      0.062205         1.175       0.2402   MID ATLANTIC
REG3         1      0.015090      0.045931         0.329       0.7425   S. ATLANTIC
REG5         1      0.022390      0.059022         0.379       0.7044   E. S. CENTRAL
REG6         1      0.153301      0.043700         3.508       0.0005   W. N. CENTRAL
REG7         1      0.146404      0.048891         2.994       0.0028   W. S. CENTRAL
REG8         1      0.215141      0.068061         3.161       0.0016   MTN
REG9         1     -0.003642      0.060504        -0.060       0.9520   PACIFIC
CONTROL1     1     -0.246845      0.033251        -7.424       0.0001   PROPRIETARY
CONTROL2     1     -0.276583      0.069158        -4.001       0.0001   NONFED GOVT
TEACH1       1     -0.015263      0.048051        -0.318       0.7508   OTHER TEACHING HOSP
TEACH2       1     -0.122011      0.106207        -1.149       0.2507   MAJOR TEACHING HOSP
```

```
DEP VARIABLE: OM        OPERATING MARGIN

                     SUM OF          MEAN
SOURCE     DF       SQUARES        SQUARE        F VALUE        PROB>F

MODEL      24     23.028428      0.959518         43.747        0.0001
ERROR    6453       141.535      0.021933
C TOTAL  6477       164.563

     ROOT MSE      0.148099      R-SQUARE         0.1399
     DEP MEAN   0.007684023      ADJ R-SQ         0.1367
     C.V.          1927.358

                  PARAMETER      STANDARD    T FOR HO:                        VARIABLE
VARIABLE   DF      ESTIMATE         ERROR  PARAMETER=0   PROB > |T|             LABEL

INTERCEP    1     -0.022984   0.008051017       -2.855       0.0043  INTERCEPT
PPSTOP      1      0.018339   0.006445346        2.845       0.0045
PPSBOT      1     -0.021498   0.006556522       -3.279       0.0010
PPS         1      0.037336   0.004490388        8.315       0.0001
BED1        1     -0.096244    0.00715609      -13.449       0.0001  RURAL <50
BED2        1     -0.021111   0.007258701       -2.908       0.0036  RURAL 50-99
BED3        1   -0.00131837   0.008384617       -0.157       0.8751  RURAL 100-169
BED4        1   0.005735067      0.010499        0.546       0.5849  RURAL >169
BED5        1     -0.049116   0.007814295       -6.285       0.0001  URBAN <100
BED6        1      0.012947   0.007978359        1.623       0.1047  URBAN 200-299
BED7        1      0.013599    0.00959453        1.417       0.1564  RUBAN 300-404
BED8        1      0.027024      0.012219        2.212       0.0270  URBAN 404-504
BED9        1      0.037758      0.012991        2.907       0.0037  URBAN >504
REG1        1      0.031340      0.018468        1.697       0.0897  NEW ENGLAND
REG2        1      0.063122   0.009038779        6.984       0.0001  MID ATLANTIC
REG3        1      0.011703    0.00628906        1.861       0.0628  S. ATLANTIC
REG5        1      0.050839   0.008212207        6.191       0.0001  E. S. CENTRAL
REG6        1      0.050487   0.006213401        8.126       0.0001  W. N. CENTRAL
REG7        1     -0.019120   0.006453206       -2.963       0.0031  W. S. CENTRAL
REG8        1      0.015994   0.009396439        1.702       0.0888  MTN
REG9        1   0.007045742   0.007703749        0.915       0.3604  PACIFIC
CONTROL1    1      0.031025   0.004615907        6.721       0.0001  PROPRIETARY
CONTROL2    1      0.082025   0.006476928       12.664       0.0001  NONFED GOVT
TEACH1      1     -0.022472   0.006852854       -3.279       0.0010  OTHER TEACHING HOSP
TEACH2      1     -0.136241      0.016165       -8.428       0.0001  MAJOR TEACHING HOSP
```

```
DEP VARIABLE: FTE       TOTAL FT EQUIV STAFF

                      SUM OF           MEAN
SOURCE       DF      SQUARES         SQUARE        F VALUE         PROB>F

MODEL        24   2420529223      100855384       1732.074         0.0001
ERROR      7715    449229847      58228.107
C TOTAL    7739   2869759070

    ROOT MSE         241.305       R-SQUARE         0.8435
    DEP MEAN         460.092       ADJ R-SQ         0.8430
    C.V.            52.44713

                   PARAMETER       STANDARD     T FOR HO:                           VARIABLE
VARIABLE     DF     ESTIMATE          ERROR   PARAMETER=0    PROB > |T|              LABEL

INTERCEP      1      395.861      12.126907        32.643        0.0001   INTERCEPT
PPSTOP        1   -31.995258       9.786808        -3.269        0.0011
PPSBOT        1     7.457906       9.524201         0.783        0.4336
PPS           1    -6.948974       6.713055        -1.035        0.3006
BED1          1     -314.694      10.624750       -29.619        0.0001   RURAL <50
BED2          1     -219.158      10.792772       -20.306        0.0001   RURAL 50-99
BED3          1   -55.463395      12.483407        -4.443        0.0001   RURAL 100-169
BED4          1      236.945      16.010240        14.800        0.0001   RURAL >169
BED5          1     -229.450      11.295832       -20.313        0.0001   URBAN <100
BED6          1      326.236      11.673879        27.946        0.0001   URBAN 200-299
BED7          1      677.420      13.856392        48.889        0.0001   RUBAN 300-404
BED8          1     1133.596      17.886069        63.379        0.0001   URBAN 404-504
BED9          1     1971.373      19.073509       103.357        0.0001   URBAN >504
REG1          1    58.102448      21.761134         2.670        0.0076   NEW ENGLAND
REG2          1     5.747306      14.290507         0.402        0.6876   MID ATLANTIC
REG3          1     3.984460       9.841077         0.405        0.6856   S. ATLANTIC
REG5          1   -28.875052      11.534441        -2.503        0.0123   E. S. CENTRAL
REG6          1     3.483403       9.843616         0.354        0.7234   W. N. CENTRAL
REG7          1   -19.386187       9.906009        -1.957        0.0504   W. S. CENTRAL
REG8          1    20.755080      13.222631         1.570        0.1165   MTN
REG9          1    61.560248      10.405924         5.916        0.0001   PACIFIC
CONTROL1      1     2.602287       6.911659         0.377        0.7066   PROPRIETARY
CONTROL2      1   -82.214808       9.427868        -8.720        0.0001   NONFED GOVT
TEACH1        1      150.503       9.855062        15.272        0.0001   OTHER TEACHING HOSP
TEACH2        1      915.397      21.233934        43.110        0.0001   MAJOR TEACHING HOSP
```

HOSPITALS

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DISTRESSED HOSPITALS UNDER PPS

Working Paper

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August 31, 1988

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Office of Research
Baltimore, MD 21207

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Introduction

Financially distressed hospitals have been the subject of many analyses over the past decade. In general, research has focused on differentiating between financial problems associated with poor management and problems created by populations served and services provided. This distinction reflects a conviction that those hospitals suffering financial shortfalls because of their location and/or willingness to provide care to the uninsured or underinsured may require (and deserve) public assistance, while those suffering because of mismanagement of resources may not. So, for example, Kelly and O'Brien[1] compare distressed and solvent hospitals in such categories as source of payment, services offered, etc. while Hadley, Mullner, and Feder[2] explore the importance of a city's bond rating, population decline, and "white flight" to the health of its hospitals.

However, aside from general observations about the importance of Medicare reimbursement policies to these hospitals, none of these studies have investigated the effect of Medicare's recent transition to a Prospective Payment System (PPS). Therefore, the purpose of this paper is to describe the experience of "financially distressed" hospitals under PPS. In particular, we will investigate:

- the attributes of financially distressed hospitals under TEFRA;
- the anticipated effect of PPS on these hospitals;
- the actual experience of these distressed hospitals under PPS;
- the attributes of hospitals that were financially distressed by the third year of PPS (PPS3);
- the stability of the cohort of distressed hospitals over time.

Neither theory nor accounting practice offer a universally accepted definition of financial distress. Because a financially sound hospital may in any given year show signs of distress due to unexpected expenses or delayed revenue receipts, most analysts have used definitions which use more than one year of data to distinguish those hospitals which may have serious, longer term financial problems from those suffering windfall losses. Hadley, Mullner, and Feder, for example, define as distressed those hospitals which have a deficit (variously defined) in at least two of the four years for which they have data. However, since our data start with the year immediately before the start of PPS (the TEFRA year), we cannot apply this definition without confounding our pre- and post-PPS comparisons. Therefore, we have developed alternative definitions which combine several different measures in one year (here the TEFRA year) rather than one measure across several years.

---

[1] "Characteristics of Financially Distressed Hospitals", NCHSR Hospital Cost and Utilization Project Research Note 3, June 1983).

[2] "The Financially Distressed Hospital", New England Journal of Medicine, Vol. 307, No. 20, 11 Nov 1982, pp. 1283-1287.

We have used total margin, liquidity, debt ratio, and occupancy rate, defined in Table 1, as the key variables to identify financial weakness and to track steps taken to overcome it. However, since the use of debt varies between urban and rural hospitals, we think that requiring a high debt ratio to indicate distress could cause us to overlook rural hospitals which may be otherwise troubled. And since "low" occupancy rates (under 50 percent) appear at the same rate among apparently solvent and distressed hospitals,[3] we are reluctant to require a low occupancy rate. Therefore, we have constructed three alternative categories to define distressed hospitals. Hospitals in the lowest decile (highest, for debt ratio) of each measure in the TEFRA year are included in the following groups:[4]

DISTRESS1: total margin and liquidity

DISTRESS2: total margin, liquidity and debt ratio

DISTRESS3: total margin, liquidity and occupancy rate

If a hospital experiences a low level of liquidity in a given year but is otherwise sound, it does not qualify as distressed. Only by falling into all of the appropriate deciles does the hospital earn this designation. Although we think that distressed hospitals will certainly be experiencing liquidity and profit problems, we are less certain that debt ratios MUST be high or occupancy rates low for a hospital to be experiencing serious financial difficulties. Therefore, we will consider these three definitions in parallel, and will remark on the importance of any discrepancies we may find among them.

---

[3] Using the DISTRESS1 and solvent definitions below, we compared the rate at which distressed and solvent hospitals had occupancy rates below 50 percent -- they were very similar, with 30 percent "low occupancy".

[4] Bottom (or top, for debt ratio) decile for each variable from the TEFRA cost reports: 0.054 for total margin, 0.998 for liquidity, 0.324 for occupancy and 2.517 for debt ratio.

TABLE 1

VARIABLE DEFINITIONS

Variable	Definition
Total margin	(Total revenue - total expenses)/total revenue
Liquidity	Current assets/current liabilities
Debt ratio	Long term liabilities/fund balances
Occupancy rate	Total inpatient days/(total beds * 365 days)
Operating margin	$\frac{\text{Net patient revenues - operating expenses}}{\text{net patient revenues}}$
Length of stay	Total inpatient days/total discharges
Medicare length of stay	Medicare inpatient days/Medicare discharges
Inpatient cost per discharge	Total direct inpatient cost/total discharges
Inpatient revenue per discharge	Total inpatient revenue/total discharges
Total expense per adjusted discharge	$\frac{\text{Total expense}}{\text{total discharges} * \frac{\text{total patient revenue}}{\text{total inpatient revenue}}}$
Total revenue per adjusted discharge	$\frac{\text{Total revenue}}{\text{total discharges} * \frac{\text{total patient revenue}}{\text{total inpatient revenue}}}$
Adjusted day per FTE	Total days *(total pat. rev./total inpat. rev.)/FTE

For comparison, we define a group of hospitals which appear unambiguously non-distressed, or solvent. This category includes those hospitals which are in the highest (or lowest, for debt ratio) quartile of all four measures: total margin, liquidity, debt ratio and occupancy rate.[5] These hospitals are considered to be the most clearly solvent, or not distressed, group that we can define.

The "solvent" group of hospitals lies the farthest from hospitals in distress on the available financial measures. DISTRESS2 and DISTRESS3 categories define subsets of hospitals that are also part of the broader category, DISTRESS1. However, there is no overlap between the DISTRESS and SOLVENT groups. Quartiles were selected to define the solvent group because a classification based on deciles yielded too few hospitals for meaningful comparisons with the distressed groups.

Distressed Hospitals Before the Implementation of PPS

In the TEFRA period, distressed and solvent hospitals were significantly different in virtually every attribute. Table 2 presents some basic descriptive statistics about the four groups, as well as the t-value for the hypothesis that the solvent group and DISTRESS1 group are equal.

Distressed hospitals were disproportionately small, rural, non-voluntary, and non-teaching. There were also some regions with a relatively high frequency of distress, particularly the two west central regions. In contrast, hospitals in the South Atlantic, East North Central, and Pacific regions were significantly more often among the solvent group.

As suspected, including only hospitals with high debt ratios reduced the number of rural hospitals included as distressed, while requiring low occupancy rates increased it. Table 2 also suggests that proprietary hospitals have both higher debt and higher occupancy rates, since their numbers grow under the second definition of distress but decline under the third. Despite differences among the distressed groups, none dramatically affects general conclusions about how distressed hospitals compare to solvent hospitals. So, for simplicity, we will focus in the following discussion primarily on the largest distressed group, DISTRESS1.

---

[5] Top (bottom, for debt ratio) quartile in TEFRA for these variables: 0.268 for total margin, 2.821 for liquidity, 0.708 for occupancy rate, and 0.150 for debt ratio.

TABLE 2

DESCRIPTIVE STATISTICS FOR TEFRA GROUPS

	DISTRESS1: Low liquidity, total margin	DISTRESS2: Low liq,marg, high debt	DISTRESS3: Low liq,marg, occupancy rate	SOLVENT: High liq,marg, occup,low debt	t-value for H_o: SOLVENT - DISTRESS1=0
N198	128	103	180		
% Rural	65.26	57.60	72.92	27.27	-5.3
<50 beds	46.31	37.60	64.58	6.25	-9.6
50-99	13.16	13.60	8.33	7.96	-1.6
100-169	5.26	5.60	0.00	9.66	1.6
>169	0.53	0.80	0.00	3.41	2.0
% Urban	34.74	42.40	27.08	72.73	7.8
<100	17.37	21.60	20.83	6.82	-3.1
100-199	10.00	12.00	5.21	20.46	2.8
200-299	4.21	5.60	1.04	19.32	4.7
300-404	1.58	2.40	0.00	12.50	4.2
404-504	0.53	0.80	0.00	7.39	3.5
>504	1.05	0.00	0.00	6.25	2.7
% Voluntary	33.84	26.56	33.01	65.00	6.4
Proprietary	33.33	48.44	16.50	11.11	-5.3
Non Fed. Govt.	32.83	25.00	50.49	23.89	-1.9
% Nonteaching	94.65	95.97	97.89	60.23	-8.7
Other teaching	3.21	2.42	2.11	31.25	7.7
Major teaching	2.14	1.61	0.00	8.52	2.8
% New England	3.54	0.78	0.97	1.11	-1.5
Mid Atlantic	1.52	2.34	0.97	2.78	0.9
South Atlantic	6.57	7.81	4.85	19.44	3.8
EN Central	6.57	3.91	4.85	13.33	2.2
ES Central	20.20	25.78	0.97	15.00	-1.3
WN Central	17.68	10.94	21.36	1.67	-5.3
WS Central	22.22	24.22	21.36	8.33	-3.8
Mountain	6.06	7.81	15.53	2.78	-1.5
Pacific	15.66	16.41	29.13	35.56	4.6

Expected Financial Gain under PPS

Before looking at the actual experience of distressed hospitals as they moved onto PPS, it may be helpful to look at their EXPECTED experience under PPS. We will define a variable, GAIN:

GAIN = Medicare dependence * (PPS payment-TEFRA costs)/TEFRA costs

This variable is designed to capture the hospital-level pressures of PPS by taking into account both the relative importance of Medicare to the hospital (Medicare discharges as a percent of the total) and the expected gap (or surplus) per case between expected PPS payment and the hospital's costs (here represented as TEFRA costs). Since PPS was phased in over a four-year period and since we are uncertain about the best representation of hospital administrators' planning horizons, we have created two versions of GAIN: a short run version, GAINSR, which uses a hospital's expected PPS payments in the first year of PPS, and a long run version, GAINLR, which uses the hospital's final, nationally-based PPS payments. Since we care more how hospitals expected to fare relative to their peers, we convert both variables to quartiles, based on the distribution of GAIN across all short-term general hospitals. It is important to note that these variables are meant to capture a hospital's perspective before starting PPS, and does not necessarily reflect its actual experience.

In the entire universe of short-term hospitals, most (76%) had the same quartile position based on the two GAIN variables -- it appeared that they would be in relatively the same position during the first year of the transition period as under full national rates. The remaining hospitals were equally distributed between those whose GAIN positions in the short run fell short of or exceeded long run GAIN. Table 3 shows the cross-tabulation of GAINSR and GAINLR for distressed and solvent hospitals. As the table shows, there are a disproportionate number of hospitals in the distressed group with long run gains superior to first year gains (off-diagonal elements above and to the right of the diagonal), and among the solvent hospitals a disproportionate number appeared to be better off in the short run. To test whether these apparent differences were statistically significant, we adapted the nonparametric sign test. For this application, we assigned the upper right off-diagonal entries positive signs. According to the sign test, the number of positive entries is binomially distributed $b(n,.5)$ and, for large n, has a standard normal statistic given by $z = (\# \text{ positive} - n/2) / \text{sqrt}(n/4)$. Using this statistic, with n given by the total number of off-diagonal elements, we can confirm that for both the distressed and solvent groups the off-diagonal elements are not randomly distributed above and below the diagonal.[6] This suggests that the average distressed hospital may have improved somewhat under full transition to PPS. In addition, when we select the analogous group of hospitals that are distressed in PPS3 we may include only a few of the TEFRA distressed hospitals.

Table 3 also shows that the distribution of anticipated effects of PPS was the same among distressed and solvent hospitals. The distributions of both groups across GAIN quartiles are equal, implying that PPS was neutral as to starting financial position. Distressed hospitals were just as likely as solvent to be at the top of the GAIN distributions, and solvent hospitals were just as prevalent as distressed at the bottom of the distributions.

TEFRA Distressed Hospitals under PPS

Between the TEFRA and PPS3 payment periods, distressed hospitals improved their financial position in almost every respect, while solvent hospitals' positions deteriorated slightly. Table 4 shows the means of several financial, cost, and output measures for both the distressed and solvent groups across the four years, and Table 5 shows the ratio of the PPS3 to the TEFRA means for the cost and utilization measures. The tables suggest that despite persistently low occupancy rates, the distressed hospitals did indeed enjoy increasingly sound financial positions as PPS was phased in. Both total margin and liquidity improved significantly between TEFRA and PPS3, while they declined slightly for the solvent group. The volume and resource utilization measures suggest that the distressed hospitals may have taken steps to achieve better performance -- Medicare length of stay dropped significantly and adjusted days per FTE increased almost a day, although the change is not statistically significant. And although total expense per adjusted discharge grew by 20 percent between TEFRA and PPS3, total revenue per adjusted discharge grew over 40 percent.

In contrast, cost outpaced revenue growth for the solvent group. Inpatient cost per discharge grew over 60 percent, while inpatient revenues grew 44 percent. Total cost growth (per adjusted discharge) exceeded total revenue growth, by 10 percentage points. Both total margin and liquidity deteriorated for this group, from TEFRA to

---

[6] For the distressed group, there are 38 off-diagonal elements, 26 of them "positive" by our rule. This gives us $z = 2.27 = (26-(38/2))/\mathrm{sqrt}(38/4)$. For the solvent group, there are 31 off-diagonal elements, 8 of them positive -- $z = -2.69$. We also used this statistic to confirm that for the overall population, the off-diagonal elements are indeed equally above and below the diagonal -- the test statistic was 0.78.

TABLE 3

SHORT RUN AND LONG RUN GAINS FOR TEFRA GROUPS

Distressed (Low liquidity and total margin)

Long Run GAIN Quartile

		1	2	3	4	
Short Run GAIN Quartile	1	45	6	1	2	54
	2	5	22	7	0	34
	3	1	3	26	10	40
	4	0	0	3	36	39
		51	31	37	48	167

Solvent (High liquidity, total margin, occupancy rate, and low debt ratio)

Long Run GAIN Quartile

		1	2	3	4	
Short Run GAIN Quartile	1	40	2	0	0	42
	2	3	29	3	0	35
	3	1	10	29	3	43
	4	0	0	9	31	40
		44	41	41	34	160

TABLE 4

FINANCIAL, OUTPUT, COST & REVENUE MEANS FOR TEFRA GROUPS
(Standard errors in parentheses)

	Distressed				Solvent			
	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
Total Margin	-0.09	0.06	0.08	0.11	0.36	0.27	0.28	0.28
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Liquidity	0.62	1.60	1.69	1.78	3.61	2.44	2.44	2.44
	(0.03)	(0.10)	(0.10)	(0.11)	(0.09)	(0.09)	(0.09)	(0.10)
Debt Ratio	1.44	1.23	1.38	1.33	0.05	0.89	1.09	0.85
	(0.27)	(0.19)	(0.19)	(0.19)	(0.01)	(0.12)	(0.15)	(0.12)
Occupancy Rate	0.42	0.38	0.37	0.36	0.79	0.71	0.68	0.67
	(0.01)	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)
Operating Margin	-0.23	-0.09	-0.12	-0.12	0.05	0.04	0.04	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
Total LOS	5.71	5.31	5.36	5.48	6.79	6.06	5.93	5.80
	(0.14)	(0.16)	(0.17)	(0.21)	(0.14)	(0.13)	(0.14)	(0.14)
Medicare LOS	7.46	6.20	6.21	6.00	9.03	7.95	7.97	8.07
	(0.14)	(0.14)	(0.16)	(0.14)	(0.16)	(0.12)	(0.12)	(0.15)
Total Discharges	206.02	207.95	205.40	204.00	857.30	859.86	836.60	791.37
	(19.74)	(21.93)	(22.63)	(26.78)	(41.51)	(42.76)	(43.74)	(47.10)
Medicare Discharges	66.51	65.26	60.72	62.47	260.72	249.16	241.10	224.56
	(5.71)	(5.56)	(5.16)	(6.15)	(12.96)	(12.57)	(12.26)	(12.83)
Beds	81.06	77.36	76.49	78.23	247.49	237.86	233.37	215.79
	(7.07)	(6.25)	(6.17)	(7.26)	(13.77)	(12.71)	(12.15)	(12.72)
Adjusted Day	6.86	7.61	7.60	7.57	9.25	7.42	7.20	7.24
per FTE	(0.29)	(0.27)	(0.28)	(0.25)	(0.26)	(0.17)	(0.20)	(0.22)
Inpatient Cost	3724.57	3614.08	4280.99	4959.63	2795.74	4006.77	4470.71	4590.00
per Discharge	(640.61)	(555.11)	(514.41)	(608.25)	(154.16)	(379.67)	(432.42)	(473.17)
Inpatient Revenue	3136.18	3366.19	3819.60	4547.25	3769.51	4666.01	5043.86	5440.86
per Discharge	(552.92)	(447.58)	(440.00)	(548.62)	(195.01)	(327.88)	(357.75)	(419.00)
Total Expense per	3695.25	3403.76	3824.97	4433.63	2547.41	3782.15	3979.07	4192.70
Adjusted Discharge	(715.80)	(569.52)	(511.54)	(627.30)	(141.81)	(412.73)	(395.01)	(451.27)
Total Revenue per	3483.53	3582.95	4174.39	4894.06	3912.44	5365.99	5752.35	6074.76
Adjusted Discharge	(737.65)	(461.08)	(455.48)	(576.75)	(208.45)	(583.21)	(608.38)	(667.77)

TABLE 5

RATIO OF PPS3 TO TEFRA MEANS FOR SELECTED OUTPUT, COST & REVENUE MEASURES FOR TEFRA GROUPS

	Distressed	Solvent
Occupancy Rate	.86*	.85
Total LOS	.96	.85*
Medicare LOS	.80*	.89*
Total Discharges	.99	.92
Medicare Discharges	.94	.86
Beds	.97	.87
Adjusted Days per FTE	1.10	.78*
Inpatient Cost per Discharge	1.33	1.64*
Inpatient Revenue per Discharge	1.45	1.44*
Total Expense per Adjusted Discharge	1.20	1.65*
Total Revenue per Adjusted Discharge	1.40	1.55*

*Ratio is different from 1 at 5% significance level or better.

PPS3. The solvent group also exhibited evidence of possible cost-saving behavior, in significant length of stay declines. However, unlike the distressed hospitals, solvent hospitals experienced a decline in adjusted days per FTEs.

So in addition to seeing some improvement among the distressed group, we see the position of the solvent hospitals deteriorating. Overall, Tables 4 and 5 suggest an overall evening of financial positions -- a narrowing of the gap between the lowest and highest positioned hospitals.

Distressed Hospitals after the PPS Transition

Much of the above suggests that the distressed hospitals of the TEFRA year may not have been distressed by the third year of PPS. It would be interesting to compare characteristics of hospitals that were distressed (or solvent) in PPS3, and compare their response to PPS with responses of their TEFRA counterparts. Therefore, we have defined PPSDIST1, PPSDIST2, PPSDIST3, and PPSSLVNT exactly as we did in the TEFRA year, this time using data from PPS3 cost reports. Table 6 describes the four groups, and again includes the t-values comparing the DISTRESS1 group with the solvent group.[7] Beside slight differences among the regions, the only change between these figures and those on Table 2, which compares TEFRA year distressed and solvent hospitals, is that nonfederal government hospitals are no longer overrepresented among distressed hospitals. It is noteworthy that all three distressed groups and the solvent group in PPS3 include much smaller percentages of the population than they did in TEFRA. This means that there were fewer hospitals which had both low margins and low liquidity or high debt, as well as fewer hospitals which had both high margins and high liquidity and low debt, again suggesting a sort of "convergence to the mean" across financial measures under PPS.

Table 7 shows the cross-tabulation of the distressed and solvent groups defined in TEFRA and PPS3. As suspected, there are very few hospitals in both distressed groups -- only seventeen percent of those distressed in PPS3 had been distressed in TEFRA. So

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[7] Bottom (or top, for debt ratio) decile for each variable from the PPS3 cost reports: 0.030 for total margin, 0.971 for liquidity, 0.222 for occupancy and 2.878 for debt ratio. For defining the solvent group, the top (or bottom, for debt ratio) quartile for each variable in PPS3: 0.286 for total margin, 2.964 for liquidity, 0.588 for occupancy rate, and 0.065 for debt ratio. Comparing these cutoffs with those for the TEFRA year show a dramatic overall shift in the distribution of occupancy rates among all hospitals -- the top quartile dropped from 71% under TEFRA to only 59% under PPS3, with the bottom tenth dropping from 32% to 22% percent.

TABLE 6

DESCRIPTIVE STATISTICS FOR PPS3 GROUPS

	DISTRESS1: Low liquidity, total margin	DISTRESS2: Low liq,marg, high debt	DISTRESS3: Low liq,marg, occupancy rate	SOLVENT: High liq,marg, occup,low debt	t-value for H_o: SOLVENT-DISTRESS1=0
N109	24	57	55		
% Rural	70.37	66.67	80.36	36.36	-3.3
<50 Beds	60.19	50.00	69.64	12.73	-6.4
50-99	7.41	12.50	8.93	1.82	-1.5
100-169	2.78	4.17	1.79	16.36	3.2
>169	0.00	0.00	0.00	5.46	2.5
% Urban	29.63	33.33	19.64	63.64	4.4
<100	22.22	25.00	16.07	7.27	-2.4
100-199	3.70	4.17	1.79	14.55	2.5
200-299	1.85	0.00	1.79	20.00	4.2
300-404	1.85	4.17	0.00	10.91	2.6
404-504	0.00	0.00	0.00	7.27	2.9
>504	0.00	0.00	0.00	3.64	2.0
% Voluntary	44.04	41.67	45.61	60.00	1.9
Proprietary	20.18	33.33	22.81	7.27	-2.2
Non Fed. Govt.	35.78	25.00	31.58	32.73	-0.4
% Non teaching	95.37	95.83	100.00	54.55	-7.3
Other teaching	3.70	4.17	0.00	32.73	5.6
Major teaching	0.93	0.00	0.00	12.73	3.4
% New England	0.00	0.00	0.00	0.00	n.a.
Mid Atlantic	0.00	0.00	0.00	7.27	2.9
South Atlantic	11.93	16.67	12.28	16.36	0.8
EN Central	13.76	20.83	14.04	7.27	-1.2
ES Central	7.34	8.33	7.02	10.91	0.8
WN Central	16.51	4.17	17.54	0.00	-3.3
WS Central	25.69	20.83	24.56	18.18	-1.1
Mountain	15.60	20.83	14.04	1.82	-2.7
Pacific	9.17	8.33	10.53	38.18	4.8

TABLE 7

COMPARISON OF TEFRA AND PPS3 GROUPS

		Distressed in PPS3			
		NA*	NO	YES	
Distressed in TEFRA	NA*	0	16	0	16
	NO	714	3509	90	4313
	YES	43	149	19	211
		757	3674	109	4540

		Solvent in PPS3			
		NA*	NO	YES	
Solvent in TEFRA	NA*	0	16	0	16
	NO	728	3581	33	4342
	YES	29	131	22	182
		757	3728	55	4540

*Not available because some hospitals did not have cost reports available for both years. In particular, there were 757 hospitals with TEFRA cost reports which did not have PPS3 cost reports (48 because they had closed by PPS3), and there were 16 new hospitals which had PPS3 cost reports but had not existed under TEFRA. Of the 48 hospitals which closed between TEFRA and PPS3, only 2 had been in the distressed group under TEFRA.

although we would still describe distressed hospitals as small, rural, nonteaching, and proprietary, we would not be talking about the same hospitals which were distressed under TEFRA. This is also supportive of predictions based on the GAIN variable -- the TEFRA distressed hospitals do indeed seem to be becoming better off as they move toward nationally-based reimbursement rates.

In comparison, about 40 percent of those hospitals in the PPS3 solvent group were also solvent in TEFRA. This, combined with the lower prevalence of solvency, suggests that as solvent hospitals dropped below one or more of our measure cutoffs, they were not replaced by others enjoying strength in all four measures. This is different from the reshuffling that seems to have occurred among distressed hospitals -- there were 90 newly distressed hospitals in PPS3, compared to only 33 newly solvent.

Table 8 shows the cross-tabulation of GAINSR and GAINLR for PPS3 distressed and solvent hospitals. Unlike the earlier tables for the TEFRA groups, the off-diagonal elements in these two tables are equally distributed above and below the diagonal. Therefore, neither the distressed nor solvent group were predicted to be better or worse off in the long run, suggesting that at the outset it did not appear that PPS would have a differential effect on them over time.

Since most of the distressed group in PPS3 were not in the TEFRA distressed group, we should see evidence of their "decline" between TEFRA and PPS3. Alternatively, since the TEFRA group showed improvement in the key financial variables, the PPS3 group could show no change, implying that the TEFRA group passed them as their positions stengthened. Table 9 shows the means and standard errors of several important variables for PPS3 distressed and solvent hospitals, and Table 10 shows the ratio of PPS3 to TEFRA means for the PPS3 groups. The distressed group shows evidence of decline -- total and operating margins drop, liquidity drops, the debt ratio climbs (although insignificantly). Table 9 shows that the PPS3 distressed hospitals were much smaller on average than the TEFRA distressed group, and that they had lower occupancy rates all four years. Although this group did have a significant decline in Medicare length of stay, they also had a large decline in adjusted days per FTE, a marked contrast to TEFRA distressed hospitals which provided more adjusted days per FTE under PPS. Total revenue per adjusted discharge grew 12 percent for the PPS3 group, which also experienced growth in expense per adjusted discharge of over 32 percent. This is cost growth 10 percent higher than their TEFRA year counterparts and revenue growth nearly 30 percent lower. At the same time, the PPS3 solvent group enjoyed 54 percent growth in their mean total revenue per adjusted discharge, compared to 32 percent growth in expenses.

TABLE 8

SHORT RUN AND LONG RUN GAINS FOR PPS3 GROUPS

Distressed (Low liquidity and total margin)

Long Run GAIN Quartile

		1	2	3	4	
Short Run GAIN Quartile	1	20	4	0	2	26
	2	1	12	2	0	15
	3	0	3	16	2	21
	4	0	0	5	34	39
		21	19	23	38	101

Solvent (High liquidity, total margin, occupancy rate, and low debt ratio)

Long Run GAIN Quartile

		1	2	3	4	
Short Run GAIN Quartile	1	7	1	0	0	8
	2	0	10	2	0	12
	3	0	1	8	3	12
	4	0	0	4	12	16
		7	12	14	15	48

TABLE 9

FINANCIAL, OUTPUT, COST & REVENUE MEANS FOR PPS3 GROUPS
(Standard errors in parentheses)

	Distressed				Solvent			
	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
Total Margin	0.08	0.02	-0.04	-0.15	0.25	0.30	0.33	0.36
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)
Liquidity	1.83	1.57	1.40	0.53	2.48	3.03	3.55	3.76
	(0.13)	(0.13)	(0.13)	(0.03)	(0.19)	(0.22)	(0.18)	(0.14)
Debt Ratio	1.37	1.33	1.38	1.59	0.30	0.14	0.46	0.02
	(0.36)	(0.25)	(0.23)	(0.23)	(0.08)	(0.09)	(0.43)	(0.00)
Occupancy Rate	0.39	0.32	0.28	0.25	0.74	0.69	0.69	0.71
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Operating Margin	-0.13	-0.16	-0.26	-0.34	-0.03	0.03	0.03	0.01
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Total LOS	5.36	4.97	5.16	5.24	6.29	6.03	5.93	5.89
	(0.17)	(0.19)	(0.20)	(0.27)	(0.23)	(0.36)	(0.32)	(0.27)
Medicare LOS	7.11	5.68	5.54	5.47	8.67	7.68	7.71	7.
	(0.18)	(0.19)	(0.17)	(0.16)	(0.22)	(0.22)	(0.20)	(0.19)
Total Discharges	135.59	124.60	106.93	93.35	860.92	851.91	826.28	827.00
	(18.33)	(17.76)	(16.34)	(15.54)	(74.20)	(76.83)	(74.96)	(76.72)
Medicare Discharges	44.96	42.15	36.46	31.50	220.39	214.32	207.50	204.69
	(7.71)	(7.05)	(6.61)	(6.68)	(19.84)	(19.91)	(18.91)	(18.77)
Beds	54.12	54.18	53.49	51.24	238.34	219.81	212.06	208.38
	(5.83)	(5.81)	(5.89)	(5.70)	(24.07)	(20.38)	(19.33)	(18.63)
Adjusted Day per FTE	6.97	6.13	6.39	6.11	8.69	7.75	7.52	8.01
	(0.48)	(0.37)	(0.42)	(0.47)	(0.38)	(0.39)	(0.40)	(0.44)
Inpatient Cost per Discharge	3485.60	3721.62	4348.89	5265.94	2880.49	4237.63	4508.18	4588.08
	(988.40)	(966.03)	(859.96)	(722.89)	(229.21)	(1491.97)	(1496.38)	(1267.68)
Inpatient Revenue per Discharge	3202.96	3156.65	3350.37	3545.91	3984.08	4813.26	5418.10	5639.08
	(860.17)	(769.01)	(712.02)	(617.94)	(361.49)	(1349.75)	(1457.54)	(1206.12)
Total Expense per Adjusted Discharge	3417.37	3551.22	3975.95	4526.41	3150.14	4215.31	4223.77	4151.13
	(1039.64)	(1020.08)	(866.51)	(732.37)	(301.93)	(1700.92)	(1437.93)	(1219.69)
Total Revenue per Adjusted Discharge	3653.93	3513.49	3802.13	4091.73	4265.87	6181.31	6666.93	6574.31
	(1081.55)	(811.19)	(749.98)	(669.43)	(394.64)	(2484.26)	(2440.74)	(1922.12)

TABLE 10

MEAN PERCENT CHANGE BETWEEN TEFRA AND PPS3 FOR SELECTED OUTPUT, COST & REVENUE MEASURES FOR PPS3 GROUPS

	Distressed	Solvent
Occupancy Rate	.64*	.96
Total LOS	.98	.94
Medicare LOS	.77*	.90*
Total Discharges	.69	.96
Medicare Discharges	.70	.93
Beds	.95	.87
Adjusted Days per FTE	.88	.92
Inpatient Cost per Discharge	1.51	1.59
Inpatient Revenue per Discharge	1.11	1.42
Total Expense per Adjusted Discharge	1.32	1.32
Total Revenue per Adjusted Discharge	1.12	1.54

*Ratio is different from 1 at 95% significance level or higher.

Unlike their TEFRA counterparts, the PPS3 distressed hospitals also fared badly in comparison to the solvent group. For these hospitals, although revenue grew at twice the rate it did for the solvent hospitals, total expenses grew at eight times the rate of the solvent group.

Conclusion

Returning to our list of proposed topics for investigation, we have found that:

- the group of hospitals that were financially distressed in the TEFRA period included disproportionate shares of rural, small, nonteaching, and nonvoluntary hospitals;
- a significant percentage of these hospitals appeared likely to benefit from the transition to national rates under PPS, as measured by their relative position in the GAIN variables;
- pre-PPS distressed hospitals enjoyed strengthened financial positions during the PPS transition period; there was evidence that these hospitals acted to improve their positions, keeping cost increases down and providing more adjusted days per FTE in PPS3 than in TEFRA;
- hospitals that were distressed in PPS3 were still disproportionately rural, small, nonteaching, and proprietary;
- very few (less than 20 percent) of those hospitals distressed under PPS3 had been classified as distressed under TEFRA, while nearly half of those solvent in PPS3 had been also been solvent under TEFRA.

It appears that, as far as financial strength is concerned, PPS (or the incentives it has created) has acted as a sort of equalizer, and that there were fewer hospitals at either financial extreme by the end of the third year of PPS. Table 11 shows the relative sizes of the distressed and solvent groups in TEFRA and PPS3. A total of 8.4 percent of hospitals were either distressed or solvent under TEFRA, while by the third year of PPS only a total of 4.4 percent were in one or the other extreme. And very distressed groups (DISTRESS2 and DISTRESS3) included 5.1 percent of hospitals in TEFRA and only 2.1 percent in PPS3.[8] Shrinkage was not related to closure or merger. Between the TEFRA and PPS3 periods, only 2 distressed hospitals closed or merged with other institutions.

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[8] There is, of course, double counting, since a DISTRESS2 hospital may also have low occupancy rate, putting it in DISTRESS3. Similarly, all of the very distressed hospitals are included in the DISTRESS1 population. However, since the same double counting exists in both years, it does not negate the comparison.

TABLE 11

RATES OF GROUP MEMBERSHIP IN TEFRA AND PPS3

	TEFRA	PPS3
Number of Cost Reports	4526	3785
Low liquidity and total margin	198	109
As percent of N	4.4	2.9
Low liquidity,margin & high debt	128	24
As percent of N	2.8	0.6
Low liquidity,margin & occupancy	103	57
As percent of N	2.3	1.5
High liquidity,margin,occupancy, & low debt ratio	180	55
As percent of N	4.0	1.5

Because the profile of distressed hospitals did not change between TEFRA and PPS3, the phase-in of PPS does not seem to have affected different groups disproportionately.[9] Even though group membership changed, the kind of hospital at high financial risk was the same throughout the period. Some small rural hospitals were successful and worked their way out of distress. Others, moderately successful at the beginning of PPS, dropped into the distressed category. However, the net change in this group has been favorable. There were fewer distressed hospitals in PPS3 than in TEFRA.

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[9] It is true that nonfederal government hospitals seem "better off" by PPS3 (ie no longer overrepresented among the distressed groups) but this group is so different insofaras possible revenue sources and other financial decisions that this does not seem like a dramatic finding. We replicated most of the analysis exluding these hospitals. Omitting nonfederal govenment hospitals raised the average debt ratio and lengths of stay and lowered mean costs per discharge among the distressed group, but none of the distressed/solvent comparisons or conclusions were affected.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES--

Effects of the Prospective Payment System on Hospital Costs, Utilization, and Financial Condition

Working Paper

Stephen T. Mennemeyer

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Baltimore, MD 21207

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EXECUTIVE SUMMARY

This paper examines the impact of Medicare's Prospective Payment System (PPS) on U.S. community hospitals. The study's baseline is the period under which hospitals were reimbursed by TEFRA rules (roughly 1983). Three subsequent years under PPS (PPS1, PPS2,PPS3) are then examined. Data for the study are drawn from Medicare Cost Reports and the American Hospital Association's Annual Survey of Hospitals. Hospitals were selected for the study based upon the availability of data for four consecutive years from TEFRA through PPS3.

Under PPS, hospitals were eventually to be paid a fixed amount for each hospital admission based upon the patient's diagnosis. The payment for each diagnostic category was based upon the national average cost of treatment in 1981 trended forward with further adjustment for regional wage variations and rural expense levels. The PPS program was phased in gradually so that in each year hospitals were to be paid at rates which reflected greater weight on the national PPS rates and less weight on the hospital's own costs. The intention of the program was to allow hospitals to profit if their costs for a particular diagnostic admission were below national average costs. Conversely, hospitals with above average costs for a particular diagnosis stood to lose money on each such admission.

The paper first examines which hospitals could look forward in the long run to gaining or losing revenue under PPS if they made no changes in their casemix or costs. We classify hospitals into four quartiles ranging from those "dim prospect" (GAIN Quartile 1) hospitals which could expect the largest loses in the long run to those "brightest prospect" (GAIN Quartile 4) hospitals which could expect the largest long run gains in revenue.

Examination of the distribution of hospitals by their quartile groups shows that certain types of hospitals had bright long run revenue prospects without having to make changes in their casemix or costs. These hospitals tended to be small facilities located in either rural or urban areas. In contrast, hospitals with teaching programs, large urban hospitals, and proprietary hospitals each had dimmer prospects. We would expect that hospitals with dim prospects would be under the most pressure to change either their casemix or cost structure in order to avoid the long run budget pressures threatened by PPS.

We next examine the adjustments which hospitals made during the first three years of PPS. We find that all hospitals reduced their lengths of stay, and staffing levels. The dimmest prospect hospitals tended to make proportionally larger reductions in LOS and staffing. They also had lower rates of increase in costs than hospitals which were under less pressure.

- Hospitals which had the brightest long run revenue prospects under PPS, reduced their average Medicare LOS by one day and their overall hospital LOS by about 1/2 day. Hospitals with the least favorable prospects achieved reductions of 1.7 and 0.9 days respectively.

- The hospitals with the brightest prospects had more patient days per full time equivalent worker (8.45) during the baseline TEFRA period than did the dimmest prospect hospitals (7.30). That is, the brightest hospitals had more patients being treated with fewer staff.

- Regardless of the anticipated financial impact of PPS on a hospital, patients had more staff serving them per patient day under PPS than before the program. The hospitals with brightest prospects achieved greater reductions in patient days per FTE (22 percent) over the PPS period than did the dimmest prospect hospitals (17 percent).

- All hospitals tended to retain Registered Nurses on their staff in spite of cuts in other staff. As a consequence, the mix of staff increased proportionally in favor of RNs. This staffing change may reflect either a tendency to hoard scarce RNs or an increase in the severity of illness of inpatients admitted under PPS. Some staff increase is probably due to increased outpatient volume but the data do not permit the measurement of staff by outpatient duties.

Hospitals which had bright long run revenue prospects under PPS also tended to have comparatively low costs prior to PPS. The most favored hospitals had average Medicare Inpatient Cost per Discharge which was $1,123 lower than the least favored hospitals. Thus hospitals with comparatively high costs prior to PPS were under the greatest pressure to change their costs or their casemix to avoid a long run reimbursement problem.

Hospitals accordingly adjusted their costs in response to PPS incentives. We examined several measures of cost, chief of which were Medicare Hospital Inpatient Costs per Discharge and Total Expense per Adjusted Discharge for all patients. We found that:

- The hospitals with brightest prospects were less successful about controlling their rates of Medicare patient costs increase during the first three years of PPS than were the hospitals with dimmest prospects. Under PPS, the dimmest prospect hospitals experienced increases in Medicare Inpatient Cost per Discharge cost of about 15 percent in nominal dollars[1] over a three year period while the most favored hospitals had increases of about 22 percent. Since inflation over this period was about 10 percent, neither group was successful at restraining costs increases to the general rate of inflation in the economy.

- Hospitals tended to have rates of cost increase for inpatient discharges (15 to 22 percent over 3 years) which were lower than for hospital costs per discharges adjusted for outpatient visits (about 30 percent). Thus there is some evidence that the pressures of PPS lead hospitals to examine more closely their inpatient hospital costs relative to outpatient costs.

- Hospital Outpatient Costs were not subject to PPS payments. Hospitals had incentives to discourage inpatient admissions and to encourage outpatient treatment. Under PPS all hospitals experienced decreases in inpatient admissions and increases in outpatient visits. The dimmest prospect hospitals had larger proportionate decreases in inpatient days (12 percent) than did the brightest prospect hospitals (8 percent). There is also some evidence that the brightest prospect hospitals had larger proportionate increases in outpatient visits than did the dimmest prospect hospitals.

- Hospitals with dim PPS revenue prospects also tended to have higher costs per Outpatient Visit during TEFRA than did hospitals with bright prospects. The dimmest prospect hospitals, for example, had costs per visit which were about twice as high as the brightest prospect hospitals during the TEFRA period. This difference tended to narrow over time due to cost increases by the brighter prospect hospitals.

During the first two years of PPS, hospitals tended to receive more revenue than designers of the program intended. This occurred because the original PPS rates had assumed that changes in hospital coding practices would cause revenue increases of 3.4 percent even though there would be no actual change in casemix. During the first year of PPS, however, coding changes caused increases of 8.4 in revenue. Errors in the data used to construct the PPS rates also caused overpayments. Hospitals also achieved reductions in length of stay which were greater than anticipated by program designers.

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[1] Costs unadjusted for inflation.

The net effect was a large increase in hospital operating profits. In subsequent years, the government attempted to offset these profits by allowing very low adjustments for inflation in hospital input prices. This strategy reduced hospital profits to levels which were lower (after inflation adjustments) than those prevailing before the start of the program.

The financial condition of hospitals consequently tended to improve during the first two years of PPS as measured by several common financial ratios. The hospitals with dimmest PPS prospects were less likely to experience this improvement. By the third year, many of these improvements had been lost by the other hospitals as their financial ratios returned to their TEFRA values as hospital costs caught up with low adjustments for inflation. Most notable in these ratios is the evidence that hospitals earned substantially higher margins on Medicare patients and substantially higher profits per discharge on all patients during the first two PPS periods, but these margins and profits were lost by the time of PPS3. Medicare Margin per Discharge is the difference between Medicare payments and hospital costs per discharge without considering deductibles and copays owed by Medicare beneficiaries. The margin was negative during TEFRA and PPS3 (indicating serious dependence on successful collection of copayments and deductibles or, possibly, unusual cost shifting between inpatient and outpatient services) but strongly positive during PPS1 and PPS2. Profit per discharge is calculated as the hospital's net profit or loss per inpatient discharges. It rose during PPS1 and fell thereafter.

- Hospitals with the dimmest PPS revenue prospects had average Medicare Margin per Discharge in nominal dollars of $-236 during TEFRA. The margin rose to $257 in PPS1, declined to $74 in PPS2 and returned to $-236 in PPS3 respectively. Hospitals with the brightest PPS prospects experienced a similar rise and fall in margin over a narrower range with average values of $-11, $177, $156 and $-53 over the same period.

The PPS program thus appears to have given hospitals some clear financial signals and hospitals responded to them in predictable ways.

INTRODUCTION

The Prospective Payment System (PPS) is a program of reimbursement for hospitals which participate in Medicare.[1] Beginning in the fall of 1983, the Federal government began to pay for hospital services on the basis of a fixed payment for each particular diagnosis. The fixed payment was calibrated to cover the average cost of the average hospital for treating a particular diagnosis. If a hospital had costs equal to the average for that diagnosis, it could expect to experience no change in its reimbursement. If a hospital had costs which were above the average, it would tend to lose money on each admission while if its costs were below the average, it would profit. Obviously, any hospital might make or lose money on a particular admission if that case had a shorter or longer than expected stay. However, given the random fluctuations in stay of a year's caseload, these individual variations would average out.

Medicare adopted PPS in order to reverse inflationary cost incentives which had prevailed since the inception of the program. Traditionally, Medicare reimbursed all actual costs incurred by a hospital in treating a Medicare patient. This approach created an incentive for hospitals to expand the scope and intensity of services and it gave little incentive for hospitals to search out less expensive methods of treatment. PPS was supposed to reverse the historical incentives and reward those hospitals which were successful at finding less expensive methods of treatment.

Under the PPS system, there is an inherent danger that hospitals may seriously cut the quality of treatment in order to benefit financially. To guard against this danger, the Medicare program also created a system for reviewing a random sample of hospital cases in order to investigate the adequacy of care. An independent organization designated as a Professional Review Organization (PRO) was responsible for conducting these reviews. This paper does not examine further the role of the PROs or measures of the quality of care.

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[1] Medicare is a program of health insurance for the elderly and disabled. It consists of two parts. Part A provides hospital insurance coverage to the disabled and to virtually all citizens over age 65; Part B is an optional program of insurance for the services of physicians, nursing home care and related benefits. Approximately 31.5 million people are enrolled in Medicare. Expenditures for Part A and Part B were respectively $47 billion and $22 billion in Federal fiscal year 1987.

Under PPS, hospitals were eventually to be paid a fixed amount for each hospital admission based upon the patient's diagnosis. The payment for each diagnostic category was based upon the national average cost of treatment in 1981 trended forward with further adjustment for regional wage variations and rural expense levels. PPS was phased in gradually with greater weight being placed each year on national PPS rates and lesser weight on a hospital's own costs. During PPS1, hospital costs determined 75 percent of actual payment by Medicare while 25 percent was based on the regional PPS rates. The weights on payment were to change to a 50/50 split in PPS2 and a 25/75 split in PPS3 with full scale reliance on national PPS rates thereafter.

This paper is concerned with examining the performance of hospitals under the first three periods of PPS in terms of their costs, revenues, financial well being, and utilization patterns. Companion papers will examine related topics not addressed in this paper.

This paper examines four groups of hospitals classified in quartiles according to how much their base year differences between hospital costs and long run PPS national rates. Quartile 1 consists of hospitals which would find their costs to be highest relative to long run PPS rates; these "dimmest prospect" hospitals could anticipate eventually losing money under PPS if they made no change in their casemix or costs of care. Quartile 4 consists of the opposite extreme, namely, those hospitals with the brightest prospects under long run PPS rates; with no change in costs or casemix patterns, these hospitals could expect to profit the most under PPS. Quartiles 2 and 3 consist of hospitals in intermediate positions between these extremes.

Data Sources

Data for this study was drawn from two main sources: the Medicare Cost Report (MCR) and the American Hospital Association (AHA) Annual Survey of Hospitals.

The MCR is filled out by hospitals which participate in the Medicare program and it is used as the basis for determining Medicare payments. Hospitals usually fill out this form on an annual basis coinciding with their fiscal year. The form is audited prior to final settlement. Wherever available, we used audited reports. However, we often used interim unaudited reports to obtain as many hospitals for analysis as possible. The MCR's format changes slightly from year to year in keeping with the needs of the

Medicare program. However, a large number of data items are consistently collected from year to year. The MCR is especially valuable as a source of financial information.

The AHA Annual Survey is a voluntary survey which is sent by the AHA in November of each year to all known (approximately 7,000) hospitals in the United States and its territories. The survey has a high response rate (about 92 percent) and the AHA spends considerable effort on verifying the accuracy of reported information. The AHA survey contains some information on the volume of outpatient visits and the number of staff employed in various labor categories which is not available on the MCR. The survey collects information on hospital costs and revenues. However, revenue information is not released by the AHA in a manner which permits the identification of individual hospitals. Consequently, information for this study relied on the MCR for revenue related information.

This report uses a hospital "reporting period" as the unit of analysis. A reporting period is essentially a fiscal year when a hospital was to be reimbursed under a particular set of payment rules. The periods which we consider are TEFRA, PPS1, PPS2, and PPS3. The TEFRA reporting period for a particular hospital covers the hospital's first full fiscal year after October 1, 1982 and the PPS years follow in sequence thereafter. As points of reference, one can think of these periods as calendar years 1983 (TEFRA), 1984 (PPS1), 1985 (PPS2), and 1986 (PPS3), bearing in mind that data for many of our hospitals do not exactly match with calendar years.

Our database was constructed to merge information for individual hospitals from the MCR with the AHA Annual Survey. This was done with MCRs covering the period from the TEFRA through the first three years of the Prospective Payment System (PPS1, PPS2, PPS3). For the AHA Annual Survey, we used all available Annual Surveys which were available through the 1986 survey year. The reporting period for the AHA survey is requested to be the period from October 1 of the previous year to September 30 of the year in which the survey is fielded. About 50 percent of responding hospitals actually report for this period. Others respond for various fiscal year periods (e.g., July 1 to June 30).

In many cases, a merge of MCR and AHA information can be done readily, because both instruments ask hospitals to report information for their most recently completed fiscal year. However, some hospitals may have reported information for different periods on the two instruments due to changes in their fiscal years or other events. Whenever reporting inconsistencies occurred, we merged a particular Annual Survey record with the MCR so as to achieve the best overlap of reporting periods. Since hospitals reported data in some cases for different periods, we had to standardize data to cover comparable periods of time. Data relating to "flow" variables (e.g. discharges, patient days, payroll expense, average length of stay) were consequently calibrated to a common monthly rate. "Stock" variables (e.g. number of beds, inventory of services offered) were retained in their reported form.

We selected for the analysis reported in this paper all hospitals which met the following criteria: 1) records were available on the hospital for each of the four periods from TEFRA through PPS3; 3,826 hospitals met this requirement yielding 15,304 records (4 * 3826); 2) the hospital was a community hospital as defined by the AHA, namely, a short term nonfederal hospital; 3) the hospital was not located in states (New York, New Jersey, Maryland, Massachusetts) which were waivered from participating in PPS. (Hospitals in waivered states were dropped due to problems in comparing their cost reports with those of PPS hospitals.) Our final database consisted of 13,816 records with four records on each of 3,454 hospitals. Since missing values may occur sporadically for any variable under analysis, the number of observations reported for individual variables will differ.

Measuring the Financial Impact of PPS

To measure the long run potential financial impact of PPS on a hospital, we define the variable GAIN:

$$\text{GAIN} = \text{Medicare Dependence} * \text{Rate Change}$$

where Medicare Dependence is the percentage of a hospital's facility costs accounted for by Medicare on the hospital's TEFRA year cost report. Rate Change is a ratio where the numerator is the difference in the amount which would be paid to the hospital under long run national PPS rates minus the hospital's allowable cost on its TEFRA year cost report; the denominator is again the hospital's allowable TEFRA cost. Rate change thus measures the hospital's anticipated gain or loss under long run PPS rates compared to the pre-PPS payment methodology. That is:

$$\text{GAIN} = \frac{\text{Medicare Facility Costs}}{\text{Facility Costs}} * 100 * \frac{\text{PPS Payment - Medicare Cost}}{\text{Medicare Cost}}$$

GAIN is thus the product of two elements: the hospital's Medicare Dependence and the Rate Change caused by the discrepancy between the future PPS payment schedule and Medicare's traditional reimbursement of hospital costs.

GAIN can be either positive or negative. Positive values suggest that a hospital could look forward to benefiting financially under PPS compared to the prior system while negative values suggest the opposite. The magnitude of the impact of the Medicare rate change can be either muted or enhanced by Medicare Dependence. For example, a big rate change would not matter much to a hospital with little Medicare business, but it would be terribly important to a hospital where Medicare was a major customer.

We interpret GAIN as being a measure of the anticipated financial disruption which PPS would bring to a hospital in the long run if it made no changes in its casemix or costs.

Note that our GAIN variable is one of several approaches which might be used to measure the degree of financial pressure which a hospital might anticipate from PPS. Another approach would be to calibrate the variable in terms of short run PPS rates which took more account of regional cost factors. Still another approach would be to define Medicare costs in terms of the 1982 Hospital Specific Portion (HSP) of costs which the Medicare fiscal intermediary would use with supplemental audit information in calculating a hospital's actual PPS reimbursement. These various approaches are not perfectly correlated although there is a high degree of agreement for most hospitals. We discuss some alternative approaches to defining the GAIN variable in a separate paper.[1]

Which Hospitals Would Benefit from PPS?

For most of the hospital industry, the anticipated long run impact of PPS was mildly beneficial. This is shown by the plot of the two components of the GAIN variable -- Medicare Dependence and Rate Change - against each other as shown in Figure 1. The plot applies to community hospitals for which we had data continuously reported over the period from TEFRA to PPS3. (N =3,454)

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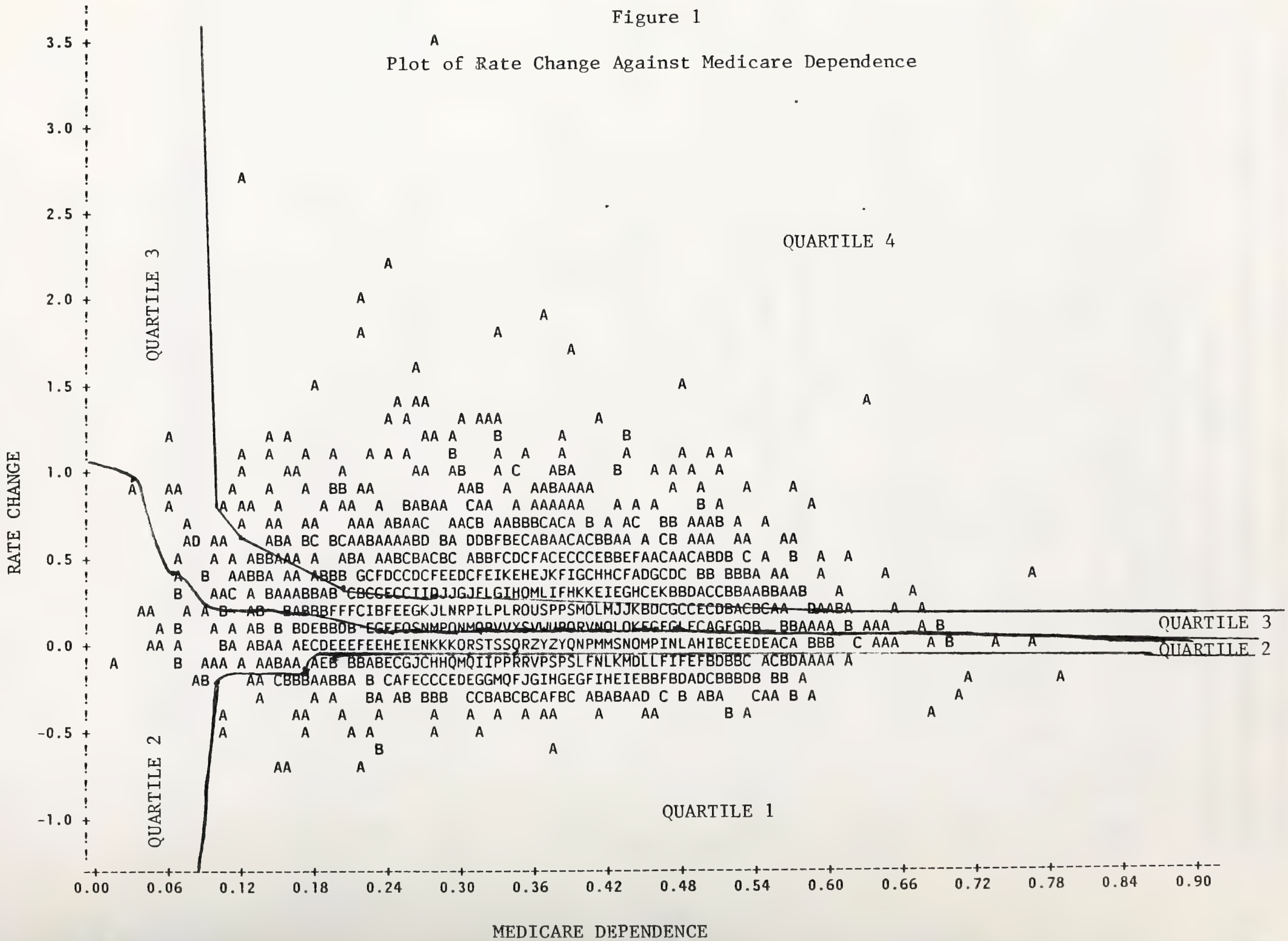
[1] Stephen Mennemeyer, "Alternate Approaches to Defining the Impact of PPS on Hospital Medicare Revenues," (Abt Associates Inc., Cambridge, MA, memorandum, October 19, 1988).

LEGEND: A = 1 OBS, B = 2 OBS, ETC.

Figure 1

Plot of Rate Change Against Medicare Dependence



NOTE: OBS HIDDEN

In the Plot, hospitals which lie above the horizontal line for zero Rate Change are those which could look forward to benefiting from the long run PPS rates if they made no changes in their casemix or costs. Those below the line would suffer since they would received less from PPS than they would have received from Medicare cost based reimbursement. As shown by the plot, the distribution of hospitals is not quite symmetric in terms of the Rate Change; more hospitals lie above the zero Rate Change line than below it, suggesting that a majority of hospitals would gain from PPS in the long run in terms of the Rate Change. The plot also shows that Rate Change was distributed fairly evenly across hospitals with different degrees of Medicare dependence. That is, a hospital's Medicare Dependence is not highly correlated with its Rate Change. Furthermore, a large number of the hospitals cluster fairly closely around the line. This implies that many hospitals could look forward to a long run Rate Change which would not be a drastic departure from Medicare's previous cost based reimbursement.

To further identify those hospital's which might expect to benefit or lose under PPS, we estimated a regression equation where GAIN was regressed on dummy variables for hospital control, teaching status, urban vs. rural location and bedsize and Census region of the country. The full regression is in the appendix. We found that long run PPS rates (inclusive of adjustments for Teaching and Capital) would appear unfavorable to hospitals which were: proprietary; engaged in teaching but which were not major teaching hospitals; urban with 505+ beds or which were located in the New England, Northeast Central or Mountain Census regions. In contrast, long run PPS rates looked favorable to hospitals which were Nonfederal Government controlled, rural with less than 100 beds, urban with under 200 beds or located in the Southeast Central and Southwest Central Census Regions.

In summary, a majority of hospitals could look forward in the long run to an improvement in their revenues under the PPS program relative to cost based reimbursement if they did nothing to change their costs or casemix. Certain types of hospitals -- especially non-major teaching hospitals and proprietary hospitals -- could anticipate less favorable treatment in the long run under PPS. Of course, any hospital could further improve its long run position if it took steps to reduce its length of stay and costs. Furthermore, a hospital could improve its long run prospects by identifying its own costs of treatment for individual diagnoses and moving to specialize in those where costs were favorable relative to long run payment rates. Hospitals which had favorable prospects under PPS were under less pressure to undertake these analyses and adjustments than were hospitals which could anticipate unfavorable reimbursement from PPS. In later sections we will examine how hospitals responded to these long run incentives.

Regression Model

To examine the responses of hospitals to the anticipated long run effects of PPS, we have used a regression model which pays particular attention to how hospitals under different degrees of financial pressure responded over time.

To analyze the data we employ a pooled time series cross sectional regression model of the following form:

$$Y = \text{Intercept} + \text{GAINYR11} + \text{GAINYR12} + \ldots \text{GAINYR43} + \text{DControl} + \text{DUrbanBed} + \text{DTeach} + \text{DRegion}$$

(We suppress here the notation for the coefficients of these variables)

The variables GAINYR11 to GAINYR43 are a set of 15 dummy variables which have a value of 1.00 for a particular interaction of the quartile of GAIN and the payment system "year" under which the hospital operated. Otherwise the dummy has a value of zero. For example, the effect on a hospital under the first year of PPS which is in the 3rd GAIN quartile is captured by the dummy GAINYR31. There is no dummy GAINYR10 since the intercept term in the regression is used to capture the effects on a hospital which was in the gain Quartile 1 (the lowest gain) and the TEFRA payment system.

Thus the scheme of the dummies is the following:

	Payment System			
	TEFRA	PPS1	PPS2	PPS3
Gain Quartile				
1	INTERCEPT	GAINYR11	GAINYR12	GAINYR13
2	GAINYR20	GAINYR21	GAINYR22	GAINYR23
3	GAINYR30	GAINYR31	GAINYR32	GAINYR33
4	GAINYR40	GAINYR41	GAINYR42	GAINYR43

(NOTE: In the appendix the variables JALYR11, JALYR12, etc. are the equivalent of GAIN11, GAIN12 etc.)

In Figure 1, contour lines indicate the relationship of the Gain Quartile with the Rate Change and Medicare Dependence. Gain is often near zero for hospitals in Quartile 2.

Since there are some missing values for observations in particular years, the number of observations usually available for major variables of interest is approximately the following:

GAIN	TEFRA	PPS1	PPS2	PPS3	Total Quartile
1	562	751	696	729	2738
2	624	783	701	770	2878
3	622	778	715	778	2893
4	673	848	761	825	3107
Total	2481	3160	2873	3102	11616

Other dummy variables in the regression are the following:

Control:

NEEDUM = 1 for Non-Federal Government control; otherwise = 0
PROPDUM = 1 for Proprietary Control; otherwise = 0

Teaching Status:

MAJTEACH = 1 for a major teaching hospital, otherwise = 0 OTHTEACH = 1 for a non-major teaching hospital, otherwise = 0

Location and Bedsize:

Rural50 = 1 for a rural hospital with less than 50 beds, otherwise =0
Rural99 = 1 for a rural hospital with 50 to 99, otherwise =0
Rural169 = 1 for a rural hospital with 100 to 169 beds, otherwise = 0
Rural170 = 1 for a rural hospital with more than 169 beds, otherwise = 0
Urban100 = 1 for an urban hospital with less than 100 beds,otherwise = 0
Urban199 = 1 for an urban hospital with 100 to 199 beds, otherwise = 0
Urban404 = 1 for an urban hospital with 300 to 404 beds, otherwise = 0
Urban504 = 1 for an urban hospital with 405 to 504 beds, otherwise = 0
Urban505 = 1 for an urban hospital with more than 505 beds, otherwise = 0
where bedsize is based upon the number of beds in the TEFRA year.

Region:

> Separate Dummies are used for the U.S. Census Regions: New England (NEWENG), South Atlantic (SOATL),Northeast Central (NECENT), Southeast Central (SECENT), Northwest Central (NWCENT), Southwest Central (SWCENT), Mountain (MOUNT) and Pacific (PACIFIC).

The intercept term in the regression applies to an urban non-teaching hospital with 200 to 299 beds under voluntary (i.e. nonprofit) control located in the Mid Atlantic Census Region. All regression models were estimated with Ordinary Least Squares.

Our model does not contain variables which control for county level health care resources (e.g., income, physicians per population, hospital beds per population). Data for these variables was not available for the PPS3 period. Since our model controls for urban/rural location, and hospital bedsize which tend to be highly correlated with county characteristics, we do not believe that the absence of these variables will greatly detract from the explanatory power of our model.

Our regression model thus allows us to capture changes, adjusted for influences associated with location and organizational type, which were specific to hospitals which were under different degrees of anticipated financial pressure from PPS. Furthermore, we can examine the time path of adjustment by these hospitals to see if responses grew or diminished over time as hospitals gained first hand experience with PPS.

Most of the tables in this report are cast in a framework which summarizes the findings of the regression analysis. A typical table shows the average value of the dependent variable for a hospital in a particular GAINYR cell. The table is calculated as the intercept term of the regression plus the coefficient of the regression for the particular GAINYR dummy in those cases where the coefficient is significantly different from zero at at least the 5 percent level. The table also reports the $\bar{R}^2$ and number of observations for the regression. All tables are calibrated in terms of a voluntary non teaching community hospital with 200 to 299 beds in the Mid Atlantic region. The full regression is reported in the appendix.

In the text, we often compare the value of one GAINYR observation with another. For example, we may compare values for PPS3 for hospitals in Quartiles 1 vs. 4. These comparisons are to be understood to involve values which are statistically different from each other at the five percent level of confidence or better unless otherwise noted.

In the next sections we discuss how hospitals responded to the anticipated long run financial pressures of PPS in terms of adjustments in occupancy and length of stay, staffing and wage rates, costs and revenues, and financial indicators.

Effects on Occupancy and Length of Stay

PPS presented hospitals with a strong incentive to reduce the length of stay of Medicare patients. Hospitals which anticipated long run financial pressures from PPS were obviously under pressure to change either their casemix or their length of stay patterns in order to avoid losing money under the anticipated PPS payments. Furthermore, even those hospitals which expected to do well under the PPS rates had clear incentives to reduce length of stay because a hospital could earn a "profit" if its cost of treating a patient was less than the amount which was to be paid by the PPS rate schedule. Strictly speaking, hospitals faced pressures to reduce their length of stay only for Medicare patients. However, in some states this incentive also applied to Medicaid patients if the state had adapted the PPS concept to that program. Furthermore, rate setting programs (e.g. prospective reimbursement) in some states and competitive pressures from other payers such as HMOs presented additional incentives for shorter stays.

To determine the effect of PPS on hospital length of stay, we estimated regressions where the dependent variables were Medicare hospital Length of Stay (HMLOS), hospital length of stay (HLOS) and hospital occupancy. The dependent variables were computed from the Medicare Cost Report.

Table 1 summarizes the findings. These regressions generally obtain good explanatory power. The $\bar{R}^2$ is fairly high for the regressions of inpatient days (.84), Medicare hospital LOS (.63), Occupancy (.49) and Outpatient visits (.46); the regression fit is weaker for hospital LOS (.23) and very weak for the ratio of inpatient days to outpatient visits (only .07). The later regression should therefore be interpreted with caution since it is unable to explain much of the variation in the data. Due to missing values for particular variables, the number of observations varies but it is always at least 11,381 hospital periods (about 2,845 hospitals per period) for this set of regressions.

Our regressions found that length of stay was generally longer for hospitals which would be more adversely affected in the long run by PPS. For example, in the TEFRA period HMLOS was 11.3 days in Quartile 1 and 9.7 days in Quartile 4. For HLOS the stays are 8 days and 6.9 days.

Length of Stay for Medicare (see Figure 2) and all patients declined over the period from TEFRA to PPS3. The rate of decline was slightly faster for Medicare patients and slightly faster for those hospitals which could anticipate greater pressure in the long run from PPS. This decline occurred almonst entirely in the period between TEFRA and PPS1. For example, Medicare LOS for Quartile 1 hospitals declined by 1.7 days (11 percent) over the period from TEFRA to PPS3; for Quartile 4 the decline was 1.0 day (10 percent). General Length of Stay (HLOS) declined by 0.9 days (11 percent) and 0.4 days (6 percent) for Quartiles 1 and 4 respectively.

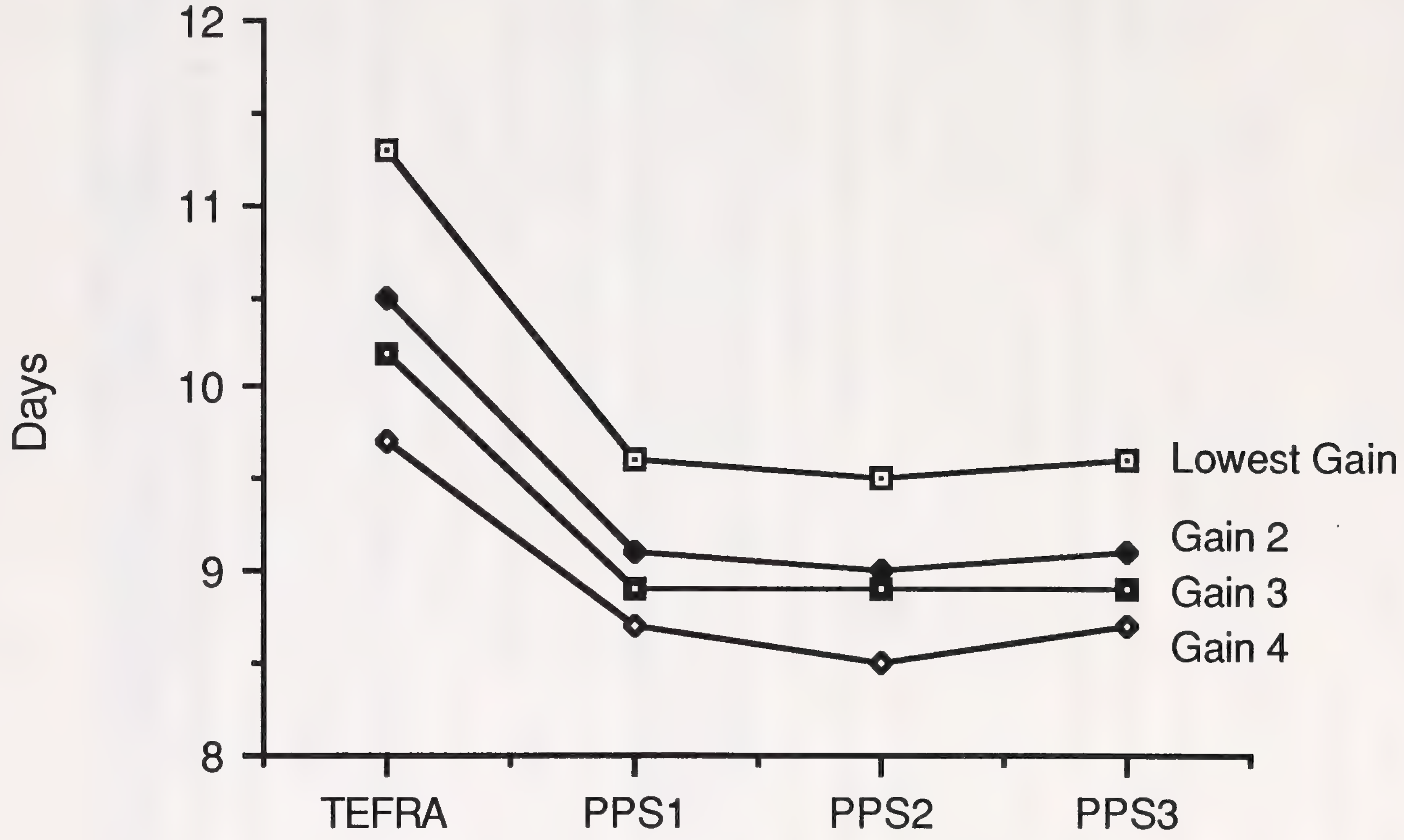
Table 1. Hospital Length of Stay and Occupancy Rate by Quartile and Payment System.

Quartile	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
						Growth		
	Hospital Length of Stay					$\bar{R}^2=.23$	N=11,615	
1	8.0	7.2	7.0	7.1	1.00	0.90	0.88	0.89
2	7.4	6.7	6.6	6.6	1.00	0.91	0.89	0.90
3	7.1	6.6	6.6	6.6	1.00	0.93	0.92	0.92
4	6.9	6.5	6.5	6.5	1.00	0.94	0.94	0.96
	Medicare Hospital Length of Stay					$\bar{R}^2=.63$	N=11,615	
1	11.3	9.6	9.5	9.6	1.00	0.85	0.85	0.85
2	10.5	9.1	9.0	9.1	1.00	0.87	0.86	0.86
3	10.2	8.9	8.9	8.9	1.00	0.88	0.87	0.87
4	9.7	8.7	8.5	8.7	1.00	0.89	0.88	0.89
	Hospital Occupancy Rate					$\bar{R}^2=.49$	N=11,615	
1	0.76	0.68	0.65	0.65	1.00	0.90	0.86	0.85
2	0.76*	0.70	0.67	0.65	1.00	0.91	0.87	0.86
3	0.78	0.70	0.67	0.66	1.00	0.91	0.86	0.85
4	0.76*	0.69	0.65	0.63	1.00	0.89	0.84	0.82
	Inpatient Days					$\bar{R}^2=.84$	N=11,381	
1	6051	5616	5431	5300	1.00	0.93	0.90	0.88
2	6123	5740	5559	5495	1.00	0.94	0.91	0.90
3	6051*	5742	5560	5481	1.00	0.95	0.92	0.91
4	5685	5456	5336	5249	1.00	0.96	0.94	0.92
	Outpatient Visits					$\bar{R}^2=.46$	N=11,381	
1	5592	5592*	5592*	5592*	1.00	1.00	1.00	1.00
2	5592*	5592*	6076	6416	1.00	1.00	1.09	1.15
3	5592*	5592*	6047	6356	1.00	1.00	1.08	1.14
4	5592*	5592*	5985	6206	1.00	1.00	1.07	1.11
	Inpatient Days/Outpatient Visits**					$\bar{R}^2=.07$	N=11,381	
1	1.60	1.60*	0.98	0.83	1.00	1.00	0.61	0.52
2	1.60*	1.60*	1.25	0.89	1.00	1.00	0.78	0.56
3	1.60*	1.60*	1.16	0.94	1.00	1.00	0.73	0.59
4	1.60*	1.60*	1.04	0.56	1.00	1.00	0.65	0.35
	Beds					$\bar{R}^2=.8937$	N=13,804	
1	261	242	238	233	1.00	0.93	0.91	0.89
2	254	243	242	239	1.00	0.96	0.95	0.94
3	246	239	237	235	1.00	0.97	0.97	0.96
4	238	237	236	235	1.00	0.99	0.99	0.99
	Discharges					$\bar{R}^2=.8589$	N=13,804	
1	728	704	685	669	1.00	0.97	0.94	0.92
2	801	776	761	746	1.00	0.97	0.95	0.93
3	802	778	762	746	1.00	0.97	0.95	0.93
4	779	755	738	724	1.00	0.97	0.95	0.93

**Figures are based upon regression equation; detail may not equal the ratio of inpatient days to outpatient visits as reported elsewhere in the table.

*Incremental value for this observation is not significantly different from baseline TEFRA, Quartile 1 at the 5 percent level of confidence.

Figure 2



Medicare Hospital Length of Stay

Occupancy rates fell almost uniformly by 15 percent in all quartiles. During TEFRA, occupancy was around 76 percent and it fell to around 65 percent for most hospitals.

Hospital Discharges also fell. For PPS1 there was a uniform reduction of 3 percent across all quartiles. Discharges continued to decline at roughly 2 percent a year for the next two years. By the time of PPS3, hospitals in Quartile 1 had experienced reductions in discharges of 8 percent compared to TEFRA levels while all other quartiles had reductions of 7 percent.

The fall in hospital discharges is something of a surprise. The financial incentives of PPS would encourage hospitals to shorten lengths of stay, but not necessarily to reduce the number of patients treated. One speculation is that the decline in discharges reflected an attempt by hospitals to treat patients on an outpatient basis whenever possible, since outpatient care remained under cost based reimbursement. (We see below that outpatient visits did rise significantly in PPS2 and PPS3 although not in PPS1.) However, this argument seems to be implausible. Patients for whom inpatient care and outpatient care are substitutable are presumably less ill. Such patients could be treated fairly quickly on an inpatient basis and thus would be profitable candidates for admission. On the other hand, the hospital would want to discourage admissions from patients who were likely to stay longer than the average stay and thus be unprofitable. These patients, however, would probably be poor candidates for outpatient care due to the severity of their illness.

The decline in discharges suggests that hospitals may have become more rigorous in their admission criteria due to PPS incentives and this had the unanticipated effect of also discouraging some admissions. Alternatively, hospitals may have been very innovative about substituting between inpatient and outpatient care so that potential long stay patients were treated more frequently on an outpatient basis.

Hospitals responded to falling occupancy and discharges by closing beds. In our sample of hospitals, the total number of beds declined by a little more than 9 percent from 520,000 to 472,000 beds. Hospitals with the dimmest prospects under PPS tended to make larger and quicker cuts. In PPS1, Quartile 1 hospitals cut their beds by 9 percent while Quartile 4 hospitals had declines of only 2 percent. Comparing PPS3 to TEFRA, beds were reduced by hospitals in Quartile 1 through 4 respectively by 14 percent, 8 percent, 8 percent and 4 percent. Thus hospitals with the dimmest prospects under PPS moved vigorously to trim their capacity, while hospitals with the brightest prospects made much smaller cuts.[1]

The number of Inpatient Days per Month fell during the period from TEFRA to PPS3 for all hospitals. In our table, the decline in this variable from TEFRA to PPS3 is greater for hospitals in Quartile 1 (12 percent) than in Quartile 4 (8 percent); however, these differences are not large enough to be statistically significant, so we cannot

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[1] Our regression equations find that occupancy, discharges, beds, and inpatient days all declined. We are satisfied that each of these variables moved in the direction indicated. By definition, Occupancy (OCC) is related to Discharges (D), average length of stay (L), Beds (B) and inpatient days (I) over a 365 day year by the formula:

$$OCC = D * L / (B * 365) = I / (B * 365).$$

The ratio of occupancy in period k to a baseline period 1 is:

$$OCC_k/OCC_1 = D_k/D_1 * L_k/L_1 * B_1/B_k = I_k/I_1 * B_1/B_k$$

Comparing ratios of PPS3 to TEFRA for these variables for Quartile 1 in Table 1, we find

$$.85 = .92 * .89 * 1.12 = .88 * 1.12$$

$$.85 \neq .92 \qquad\qquad \neq .99$$

Clearly, these particular results are not completely consistent. This may occur because the number of observations available for analysis differs among regressions due to missing values on individual variables. The appropriateness of a linear regression specification is also worth further research.

confidently say that hospitals in one quartile had larger proportional declines than in other quartiles.[1]

Thus hospitals responded as expected to the incentives of PPS by reducing their lengths of stay. Reductions in occupancy were, from the hospital's viewpoint, an undesirable but inevitable consequence of shorter stays.

PPS Effects on Staffing and Wages

One way in which hospitals may have sought to reduce costs under PPS was by trimming staff or slowing down the rate of growth in wages. In this section we examine what hospitals did in terms of staffing and pay.

We would expect that some trimming of the labor force occurred in hospitals due to the pressures of PPS and that this trimming was more severe in hospitals which were in the lower GAIN quartiles. Microeconomic theory would advise a hospital to layoff workers in proportions such that the ratios of workers' marginal products to their wage rates would remain constant across all employment categories. In practice, it might be difficult for a hospital to figure out how to implement this advise. Some hospitals may have tried to keep the mix of workers about the same while shrinking the total number. Others might prefer to layoff aides and orderlies in greater proportion than technical staff and require the latter to assume menial duties. Still another approach might have been to fire proportionally more of the higher paid staff.

Due to the costs of recruiting and training staff, hospitals could be expected to be reluctant to layoff workers unless they felt fairly sure that PPS would put them under

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[1] To test the hypothesis that GAINYR13 - GAINYR43 = 0 we compute the statistic:

$$t = (\text{GAINYR13} - \text{GAINYR43}) / \text{SQRT}\ (\text{VAR13} - \text{VAR43} - 2\ \text{COV}(13,43))$$

where VARij denotes the variance of the coefficient for GAINYRij and COV(ij,lm) denotes the corresponding covariance. SQRT denotes a square root on the expression within the parenthesis. In this example,

$$\begin{aligned} t &= (5300 - 5249)/\text{SQRT}\ (7175.27 + 6562.42 - 2 * (2677.65) \\ &= 51 / 91.56 = .55704 \end{aligned}$$

We cannot reject the hypothesis that the difference between the two GAINYR values is zero.

a long run reimbursement disadvantage. Hence, hospitals in Quartile 1 should show the largest staff reductions. Counterbalancing staff layoffs, however, would be any increase in the average severity of illness of the patients. Illness severity might increase if hospitals were more selective about admitting patients versus referrals to outpatient care.

To measure hospital staffing, we have used data from the American Hospital Association's Annual Survey of Hospitals. The survey reports total inpatient days and the number of full time equivalent staff (FTE) by job categories. We estimated a set of regression equations where the dependent variables were Inpatient Days per FTE, Inpatient Days per FTE Registered Nurses, the ratio of FTE RNs to all other hospital employees ("non-Rns"), and average monthly payroll (defined as the ratio of monthly payroll to all FTEs). Results are reported in Table 2. The table applies, once again, to an urban hospital with 200 to 299 beds under voluntary (i.e. nonprofit) control located in the Mid Atlantic Census Region.

We find that hospitals in the lowest GAIN quartile tended to have fewer patient days per FTE during the TEFRA period than did hospitals in the higher quartiles. This is not surprising since these were, after all, the hospitals which tended to have higher costs. For example, Patient days per FTE were only 7.30 for hospitals in Quartile 1 but 8.6 for Quartile 4. A similar pattern prevails for the ratio of patient days to RNs where the ratios are 27.3 and 43.6 for Quartiles 1 and 4 respectively. The hospitals in Quartile 1 also had a slightly higher ratio of RNs to other staff (.34) than did the hospitals in Quartile 4 (.31)

How did hospitals respond to PPS? The average number of employees in a hospital changed very little during the period from TEFRA to PPS3. The number of hospital FTE's remained constant for hospitals in Quartiles 1 and 2 and it decreased by 2 and 1 percent respectively for Quartiles 3 and 4. The employment of RNs also remained unchanged for hospitals in Quartiles 1 and 2 but it increased by 2 percent for hospitals in the Quartile 3 and 4.

The ratio of patient days to FTE's FELL following the implementation of PPS as shown in Figure 3. That is, hospitals patients had more staff looking after them because decreases in patient days which occurred after the start of PPS were not matched by proportional decreases in hospital employment. This is true for all quartiles. For example, the ratio of Patient days per FTE fell by about 16 to 18 percent for hospitals in

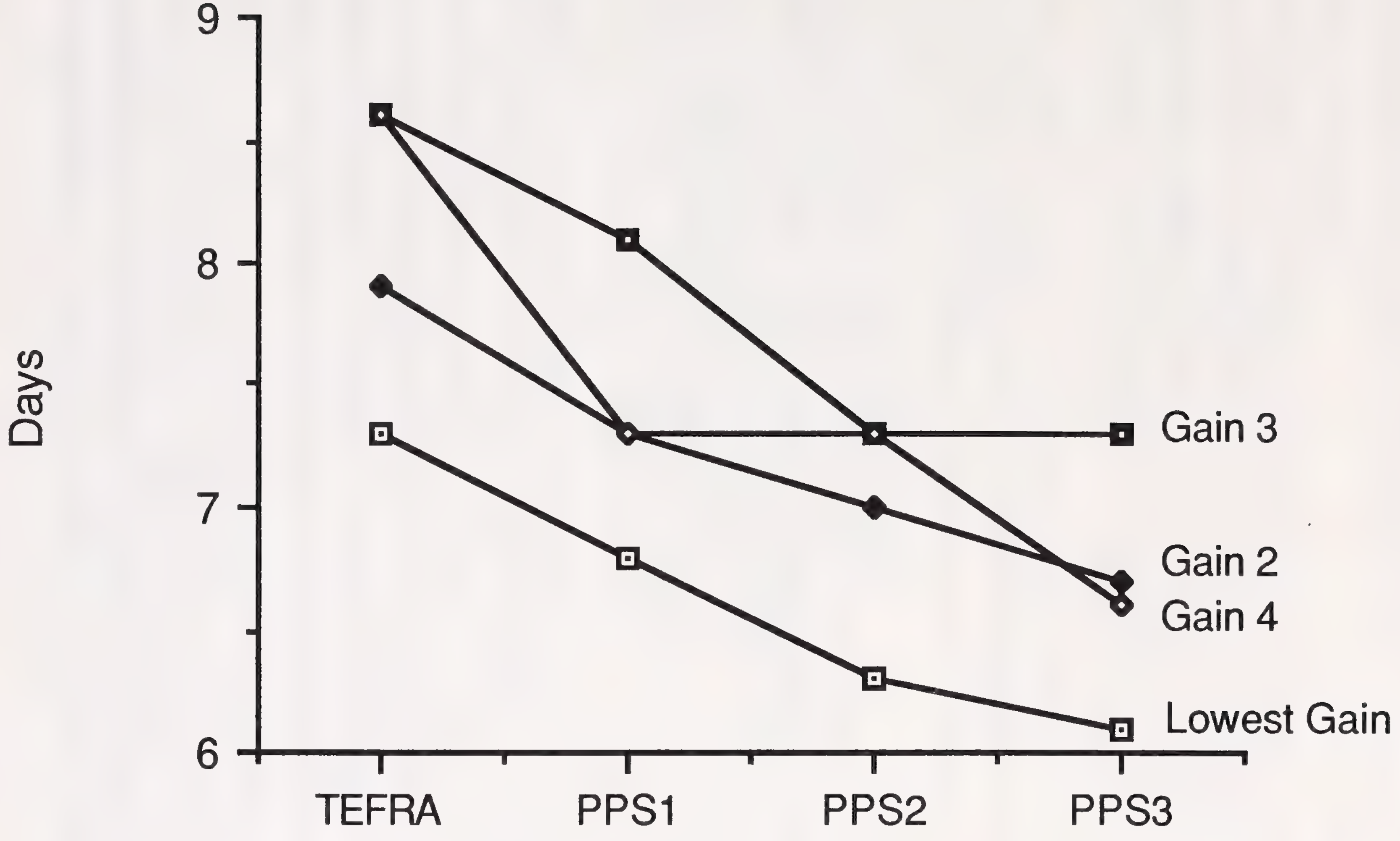
Table 2. Trends in Hospital Staffing: Patient Days per Full Time Equivalents (FTEs) for all staff, RNs, for TEFRA through PPS3 by Gain Quartile.

Quartile	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
						Growth (PPSx/TEFRA)		
	Inpatient Days Per FTE					$\bar{R}^2=.15$	N=11,012	
1	7.3	6.8	6.3	6.1	1.00	0.92	0.86	0.83
2	7.9	7.3	7.0	6.7	1.00	0.93	0.88	0.85
3	8.6	8.1	7.3	7.3	1.00	0.94	0.86	0.86
4	8.6	7.3	7.3	6.6	1.00	0.86	0.86	0.77
	Inpatient Days per FTE RN					$\bar{R}^2=.10$	N=11,012	
1	27.3	22.3	20.5	19.4	1.00	0.82	0.75	0.71
2	31.5	27.5	23.5	23.1	1.00	0.87	0.75	0.73
3	40.0	40.6	31.1	28.7	1.00	1.02	0.78	0.72
4	43.6	32.7	27.7	24.3	1.00	0.75	0.63	0.56
	RNs per Non-RNs					$\bar{R}^2=.28$	N=11,012	
1	0.34	0.36	0.36	0.37	1.00	1.04	1.06	1.07
2	0.34	0.34	0.36	0.38	1.00	1.01	1.06	1.11
3	0.33	0.34	0.35	0.37	1.00	1.04	1.07	1.11
4	0.31	0.32	0.34	0.34	1.00	1.04	1.10	1.10
	Average Monthly Pay					$\bar{R}^2=.44$	N=9,319	
1	1671	1764	1822	1867	1.00	1.06	1.09	1.12
2	1636	1709	1785	1830	1.00	1.04	1.09	1.12
3	1569	1671	1736	1784	1.00	1.07	1.11	1.14
4	1530	1597	1671	1727	1.00	1.04	1.09	1.13
	Full Time Equivalent Employees					$\bar{R}^2=.83$	N=12,049	
1	813	813	813	813	1.00	1.00	1.00	1.00
2	813	781	782	813	1.00	0.96	0.96	1.00
3	767	755	757	749	1.00	0.98	0.99	0.98
4	740	733	731	736	1.00	0.99	0.99	0.99
	Full Time Equivalent RNs					$\bar{R}^2=.82$	N=12,049	
1	203	203	203	203	1.00	1.00	1.00	1.00
2	203	197	203	203	1.00	0.97	1.00	1.00
3	190	191	194	193	1.00	1.00	1.02	1.02
4	184	184	186	188	1.00	1.00	1.01	1.02

Note: Table is based upon regressions which controls for Teaching Status, Region, Bedsize and Urban vs. Rural Location. Values in the Table are means for a voluntary, non-teaching hospital in the Mid Atlantic region.

Figure 3

Inpatient Days per FTE



Quartiles 1,2 and 3 and by 23 percent for hospitals in Quartile 4 over the period from TEFRA to PPS3.

The ratio of Patient Days per RN also fell by roughly 30 percent for Quartile 1 through 3 and by 44 percent for Quartile 4 for the same period.

We also find that the ratio of RNs to other staff increased by 6 percent for Quartiles 1 and 2 and by 7 and 10 percent for Quartiles 3 and 4 resoectively over the period from TEFRA to PPS3.

What were the effects of PPS on hospital pay? Here we have relatively weak data since the only available information comes from total payroll figures available from the AHA Annual Survey. (The MCR did not consistently collect payroll data over the period under analysis.) We again estimated a regression equation where the dependent variable was monthly payroll per FTE. We found that during TEFRA, hospitals in Quartile 1 tended to pay higher wages than hospitals in Quartile 4. For example, payroll per FTE was $1,671 per month in Quartile 1 and only $1,530 in Quartile 4. Again, this is consistent with the notion that hospitals in Quartile 1 were generally higher cost hospitals.

During the period from TEFRA through PPS3, the wage differential between quartiles remained virtually unchanged. For Quartiles 1, 2 and 4, payroll per FTE grew by 9 percent from TEFRA to PPS3; for Quartile 3 the rate of growth was 11 percent. Since these rates are close to the rate of inflation in the economy (about 10 percent), it suggests further that hospitals did little more than give cost of living adjustments in wages over this period.

The implication of our analysis is that hospitals were unable or unwilling to shed staff in proportion to decreases in patient days. They also tended to be particularly conservative about shedding RNs from their staff. This may reflect the fact that a few empty beds on a floor may reduce staff workload by they do not allow a personnel supervisor to eliminate an entire position. Hospitals may also be reluctant to lay off skilled personnel since recruitment may be difficult if patient days increase. These staffing patterns may also reflect a change in patient casemix. For example, in Table 1 we saw that outpatient visits rose during PPS2 and 3. The ratio of Patient Days to FTE does not take account of the need for staff to serve additional outpatients. Furthermore, if PPS tended to lessen stays by relatively healthy patients, those remaining patients would have been sicker and thus perhaps in need of more intensive nursing care.

Additionally, increases in outpatient visits may have absorbed staff who would otherwise have not been needed. Unfortunately, our data are not able to examine the allocation of staff to outpatient duties. Finally, as we discuss below, hospitals were not under severe financial pressures during the first 2 years of PPS. They could afford in many cases to be conservative about laying off staff until they had a better idea of what PPS would actually do to their operations and financial condition.

Effects on Cost and Revenue

In response to the anticipated long run financial pressures of PPS, hospitals could be expected to make adjustments in their costs and their pricing policies. Presumably hospitals which anticipated more adverse long run effects from PPS would act more vigorously to reduce their costs or increase their prices charged to other payers.

To measure the impact of PPS on hospital costs and revenues, we use the following variables and abbreviations:

Hospital Only Inpatient Expense/Discharges = HOICDIS
Hospital Only Inpatient Revenue/Discharges = HOIRDIS

Medicare Hospital Only Inpatient Expense/Discharges = MHOICDIS
Medicare Hospital Only Inpatient Revenue/Discharges = MHOIRDIS

Total Hospital Expense per Adjusted Discharge = TEHDB
Total Patient Revenue per Adjusted Discharge = TRHDB

Hospital Outpatient Cost / Total Outpatient Visits = HOT

These various cost and revenue measures are designed to focus on different aspects of the hospital and different elements in the hospital's cost report.

The variables HOICDIS and MHOICDIS attempt to measure the costs of hospital inpatient operations after excluding any costs which may be due to subproviders (nursing homes, home health agency) or outpatient, swingbed and emergency room services. Extraneous lines of business (gift shop, etc.) are also excluded. HOICDIS measures inpatient hospital costs for all inpatient discharges while MHOICDIS focuses on the portion of costs allocated to Medicare inpatient discharges. One advantage of this approach is that each variable has an analytically appropriate match between its numerator (hospital only inpatient costs) and its denominator (patient discharges from only the inpatient hospital).

In similar fashion HOIRDIS and MHOIRDIS attempt to measure revenue relating to only hospital inpatient activities. HOIRDIS excludes hospital revenue due to subproviders, outpatient services and emergency room and extraneous lines of business.

MHOIRDIS counts all Medicare PART A payments to the hospital for inpatient care per discharge (including, where applicable, PPS allowances for Medical education and capital passthrough). Payments under PART B (mainly medical services) are excluded.

HOIR isolates only those patient revenues attributable to Inpatient hospital care; excluded from it are all inpatient revenues attributable to subproviders, outpatient services, homehealth, ambulance, CORF, ASC and Hospice.

TEHDB is the ratio of total hospital expenses per hospital discharges adjusted to reflect the volume of outpatient services. The adjustment method is similar to that used by the American Hospital Association.[1] In similar fashion, the variable TRHDB is total

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[1] Our approach to adjusting patient discharges is conceptually similar to the approach used by the American Hospital Association in defining an adjusted patient day. This is a convenient approach for adding up different units of hospital output such as inpatient discharges and outpatient visits. The rationale for the approach is that a unit of output such as an outpatient visit can be translated into another unit such as an inpatient discharge roughly in proportion to the dollars involved in producing each unit.

For TEHDB, the numerator (TEXP) is the sum of hospital operating expenses plus other expenses for all units in the facility. The denominator (AJDISB) is based on the ratio of hospital direct operating expense to hospital direct inpatient expense. That is:

AJDISB = Discharges * (Direct Operating Expense/Inpatient Direct Operating Expense)

TEHDB = Total Hospital Expenses / AJDISB

The numerator of the ratio TRHDB is total patient revenue (inpatient plus outpatient from all entities in the facility). The denominator is again AJDISB.

In examining variables such as these which are expressed in relation to adjusted output, some caution should be used. For example, let us say that we create a measure of adjusted discharges (ADJIS) where inpatient discharges are adjusted by the ratio of hospital expense to inpatient expense:

$$\text{ADJDIS} = \text{INPDIS} * \frac{\text{TREV}}{\text{INPREV}}$$

So far, this looks fine but consider what happens if we then wish to use our measure of adjusted discharges as the denominator in an analysis of, say, revenue per adjusted discharge. Due to cancellation of terms, total revenue per adjusted day becomes simply inpatient revenue per inpatient discharge:

patient revenue (from all entities in the facility) per adjusted discharge.

"Revenue" in our variables HOIR and TRHDB should be understood as charges before bad debt, discounts and disallowances rather than as revenues actually collected. Hospital cost reports do not allow us to examine net patient revenue separately at the inpatient and outpatient levels.

These measures of hospital cost and revenue are fairly well correlated,[1] although they do not attempt to measure exactly the same aspects of cost and revenue.

Table 3 shows how these variables changed for hospitals in each of the four GAIN quartiles during the period from TEFRA through PPS3. Values in the table apply to an urban hospital with 200 to 299 beds under voluntary (i.e. nonprofit) control located in the Mid Atlantic Census Region.[2]

$$\frac{TREV}{ADJDIS} = TREV * \frac{1}{INPDIS} * \frac{INPREV}{TREV} = \frac{INPREV}{INPDIS}$$

Our variables TEHDB and TRHDB are defined to avoid such an exact algebraic cancellation. (Note the use of operating expenses in AJDISB versus Total Hospital Expenses in TEHDB.) Nonetheless, one should be cautious about using any measure of adjusted discharges because most cost and revenue elements in hospital cost report tend to be highly correlated. This implies that terms can "almost" cancel out so that the measure of adjusted output may be a crude representation of hospital performance.

[1] The correlations are the following:

	HOIRDIS	HOICDIS	MHOIRDIS	MHOICDIS	TRHDB	TEHDB
HOIRDIS	1.00	.85	.82	.81	.84	.63
HOICDIS		1.00	.82	.88	.77	.73
MHOIRDIS			1.00	.92	.70	.57
MHOICDIS				1.00	.71	.64
TRHDB					1.00	.89
TEHDB						1.00
N = 12,525						

Note: observations are for the four periods TEFRA, PPS1-PPS3; the same number of observations apply to each correlation.

[2] The values in the table are computed from the coefficients of that variable's regression model. For example, a hospital in the first GAIN quartile under the TEFRA payment system had average Medicare hospital only inpatient costs per discharge (MHOICDIS) of $4,237. This is based on the intercept of the regression (4237.27). In the PPS1 period, that hospital's costs fell to $4,166. This is the intercept plus the regression coefficient for GAINYR11 (-71.43). Similarly, for the rest of the table, values for a particular GAINYRxy are computed by adding the coefficient for that variable to the

Table 3. Hospital Expenses and Revenues By Quartile for the period from TEFRA to PPS3.

GAIN Quartile	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
		Mean Value				Growth (PPSx/TEFRA)		
	Medicare Hospital Inpatient Only Revenue/Discharge							
					MHOIRDIS	$\bar{R}^2$=.79	N=11,615	
1	4,001	4,423	4,630	4,666	1.00	1.11	1.16	1.17
2	3,439	3,796	4,001*	4,117	1.00	1.10	1.16	1.20
3	3,163	3,448	3,719	3,764	1.00	1.09	1.18	1.19
4	2,878	3,159	3,427	3,473	1.00	1.10	1.19	1.21
	Medicare Inpatient Hospital Cost/Discharge							
					MHOICDIS	$\bar{R}^2$=.74	N=11,615	
1	4,237	4,166	4,556	4,871	1.00	0.98	1.08	1.15
2	3,591	3,617	3,961	4,237*	1.00	1.01	1.10	1.18
3	3,247	3,293	3,590	3,849	1.00	1.01	1.11	1.19
4	2,889	2,983	3,271	3,526	1.00	1.03	1.13	1.22
	Hospital Only Inpatient Revenue							
					HOIRDIS	$\bar{R}^2$=.64	N=11,615	
1	4,948	4,948*	5,375	5,801	1.00	1.00	1.09	1.17
2	4,305	4,362	4,644	4,948*	1.00	1.01	1.08	1.15
3	4,023	4,069	4,329	4,640	1.00	1.01	1.08	1.15
4	3,755	3,834	4,060	4,333	1.00	1.02	1.08	1.15
	Hospital Only Inpatient Cost/Discharge							
					HOICDIS	$\bar{R}^2$=.62	N=11,615	
1	3,035	3,035*	3,274	3,507	1.00	1.00	1.08	1.16
2	2,566	2,587	2,775	2,966	1.00	1.01	1.08	1.16
3	2,341	2,386	2,546	2,725	1.00	1.02	1.09	1.16
4	2,101	2,185	2,369	2,537	1.00	1.04	1.13	1.21
	Total Expense Per Adjusted Discharge							
					TEHDB	$\bar{R}^2$=.47	N= 8,717	
1	4,061	4,504	4,952	5,355	1.00	1.11	1.22	1.32
2	3,532	3,886	4,253	4,640	1.00	1.10	1.20	1.31
3	3,306	3,620	4,061*	4,316	1.00	1.09	1.23	1.30
4	2,921	3,193	3,529	3,830	1.00	1.09	1.21	1.31
	Total Patient Revenue Per Adjusted Discharge							
					TRHDB	$\bar{R}^2$=.54	N=8,717	
1	5,682	6,134	6,720	7,342	1.00	1.08	1.18	1.29
2	5,033	5,393	5,682*	6,361	1.00	1.07	1.13	1.26
3	4,703	5,022	5,449	5,928	1.00	1.07	1.16	1.26
4	4,360	4,625	5,005	5,362	1.00	1.06	1.15	1.23
	Outpatient Cost Per Outpatient Visit							
					HOT	$\bar{R}^2$=.17	N=8,717	
1	25.68	25.68*	25.68*	25.68*	1.00	1.00	1.00	1.00
2	20.55	21.56	22.68	22.80	1.00	1.05	1.10	1.11
3	18.50	18.95	19.63	19.66	1.00	1.02	1.06	1.06
4	13.31	14.06	15.59	15.16	1.00	1.06	1.17	1.14

*Incremental value for this observation is not significantly different from baseline TEFRA, Quartile 1 at the 5 percent level of confidence

What does Table 5 show us? Consider first the effects of PPS on Medicare Hospital Only Inpatient Cost per Discharge (MHOICDIS). For GAIN Quartile 1, these costs averaged $4,237 during the TEFRA period. For GAIN Quartiles 2,3 and 4 they respectively were only $3,591, $3,247 and $2,889. That is, hospitals which would expect to benefit more in the long run from PPS were hospitals which already tended to have lower costs during the TEFRA baseline period. This implies that PPS tended to reward institutions which were already keeping their costs near the PPS target.

How did hospitals respond over time to the incentives of PPS? During the first PPS year, the hospitals in the lowest GAIN quartile slightly reduced their cost of a Medicare patient discharge by about 2 percent (to $4,166) while hospitals in the other GAIN quartiles had increases in cost of 1 to 3 percent. This is further illustrated by Figure 4. During this period general inflation (as measured by the GNP implicit price deflator) was running at about 4 percent, so all hospitals had decreases in their real cost of a Medicare discharge. By the time of PPS3, hospitals in the lowest GAIN quartile had cost increases which were 15 percent above the TEFRA baseline period. For quartiles 2, 3 and 4 the cost increases were respectively 18, 19 and 22 percent. (These increases are statistically significant at at least the 5% level of confidence.) General inflation over the period from TEFRA to PPS3 was about 10 percent, so hospitals in all GAIN quartiles had cost increases attributable to their Medicare discharges which exceed the rate of general inflation in the economy. However, hospitals tended to do better at constraining their costs in situations where they were more constrained by PPS reimbursement.

Hospital Only Inpatient Costs per Discharge (HOICDIS) for all patients shows a similar pattern. In the baseline TEFRA period, hospitals in lower quartiles have higher costs. These costs are respectively $3,033, 2,566, 2,341 and 2,101 for Quartiles 1 through 4. Inflation in hospitals costs is below the national inflation rate for the first year of PPS for all except Quartile 4 where hospital cost increases just matched national

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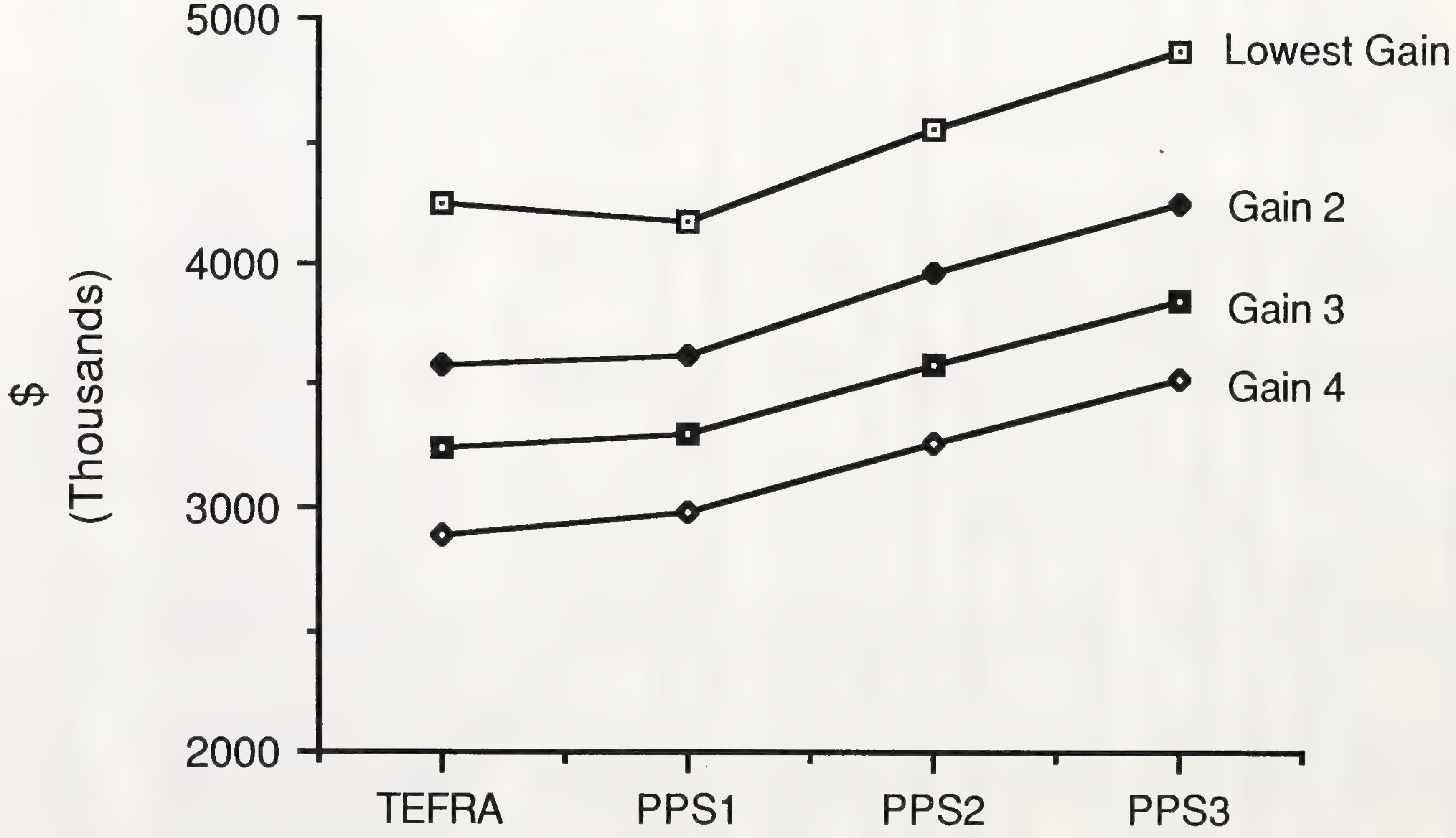
intercept whenever the coefficient is significant at the five percent level or better. The full regression is shown in the Appendix.

To determine the values for hospitals other than our baseline of a Mid Atlantic region voluntary hospital, consult the appendix; the coefficients for other dummies can be added to the values in the table. For example, to convert table values to a rural New England hospital with less than 50 beds, the coefficients for these dummies (respectively -151.630 and -805.135) are added to the appropriate value for GAIN and Payment Period. For example, such a rural New England hospital in PPS1 would have costs of 3,634.75 (that is, 3034.705 + 53.46 - 151.630 - 805.135).

Figure 4

Medicare Inpatient Cost per Discharge



inflation. By the time of PPS3, all hospital quartiles had experienced rates of cost increase which exceed the rate of general inflation. Hospitals in Quartile 4 had experienced somewhat higher rates of increase. Suggesting again, that they were more willing to incur costs since they were less constrained by PPS than were other hospitals.

The nearly identical movements in inpatient costs per discharge for Medicare and all payers suggests that hospitals are not able or willing to treat patients differently according to their source of payment. The incentives of PPS seems to have set off a major effort at cost control which affected the entire hospital inpatient activity.

We have noted earlier in a footnote some conceptual problems with measures of cost per "adjusted" patient day. As a point of curiosity, we did examine Total Hospital Cost per Adjusted Discharge (TEHDB). We found that cost levels were highest in Quartile 1 and lowest in Quartile 4. The rate of increase from TEFRA to PPS3 was more rapid (30 to 32 percent) than for our measures of "inpatient only" cost. This discrepancy does not seem to be due to movements in outpatient costs (which is supposedly what this "adjusted" variable is trying to capture) since, as we discuss below, movements in outpatient cost per visit grew at a rate similar to inpatient only cost.
This finding again casts doubt on the usefulness of "adjusted" patient days for measuring the combined costs of inpatient and outpatient care.

How did PPS affect hospital revenues? As shown in Table 3, average Medicare Hospital Inpatient Revenue per Discharge (MHOIRDIS) was $4,001 for hospitals in Quartile 1 during the TEFRA period. This level of reimbursement tended to be lower for the higher GAIN quartiles. Medicare revenue was respectively $3,439 $3,163 and $2,878 for Quartiles 2,3 and 4. That is, during the baseline period, hospitals which would expect to benefit most from PPS in the long run tended to be hospitals that were already receiving relatively low payments per discharge, after controlling for other factors such as teaching status, bedsize, and urban/rural location.

During the period from TEFRA to PPS3, Medicare revenue grew by 17, 20,19 and 21 percent respectively for hospitals in GAIN Quartiles 1,2,3 and 4. That is, hospitals in Quartile 1 which were expected in the long run to be to be most constrained by PPS had slower growth in Medicare revenue per discharge (ignoring revenue from copayments and deductibles) than other hospitals.

These differences in growth between Quartile 1 and the other quartiles are statistically significant. One might expect that there would be no differences in growth rates among quartiles since growth would largely depend upon factors such as the PPS update which would uniformly affect all hospitals. The differences which we find suggest,however, that hospitals which faced brighter prospects under PPS (i.e. Quartile 3 and 4) may have been more careful--or luckier--in their admissions of Medicare cases (we saw earlier that Medicare discharges grew at about the same rate for all hospital quartiles, so growth in cases does not seem likely to account for the different rates of growth in revenue) so as to enhance reimbursement. More attention to case coding might also account for the differences in growth. Factors accounting for the differential rate of growth are worth further investigation.

A rather different picture emerges, however, for Hospital Inpatient Revenue per Discharge (HOIRDIS). This essentially measures charges levied against all payers. In the TEFRA period we see the familiar pattern: hospitals revenue per discharge moves inversely with the GAIN quartile. Inflation patterns, however, are the opposite of what happens for Medicare. Over the period from TEFRA to PPS3, hospitals in Gain quartiles 1,2,3,and 4 respectively had revenue growths of 17,15,15, and 15 percent.[1] That is, the hospitals which had the dimmest long run PPS prospects tended to increase more their charges to other payers. (We cannot determine from our data if corresponding increases occurred in net revenues.) This also implies that lower cost hospitals in GAIN Quartiles 3 and 4 were more successful about restraining their price increases to other payers.

A similar pattern appears for Total Patient Revenue per Adjusted Discharge (TRHDB). During TEFRA, revenues were $5,682 5,033 4,703 and 4,360 respectively for Quartiles 1 through 4 indicating higher charges by hospitals which were less likely to benefit from PPS in the long run. The rate of increase in charges over the period through PPS3 was 29 percent for hospitals in Quartile 1, 26 percent for quartiles 2 and 3 and only 23 percent for hospitals in Quartile 4. Thus, patient charges seem to have grown less quickly for hospitals which stood to benefit most from PPS in the long run.

Lastly, we consider how PPS affected the costs of hospital outpatient operations. Under PPS, hospitals had strong incentives to shift costs away from their inpatient departments to other departments which were still under cost reimbursement. Hospitals also had an incentive to use the hospital outpatient department as a source of inpatient admissions for discretionary cases where the inpatient stay was likely to be brief and cheaper than the PPS allowance. They also had an incentive to use the inpatient department to render after-care to inpatients whom the hospital sought to discharge as early as possible. All of these considerations suggest that outpatient costs should have been rising strongly under PPS. Furthermore, we would expect that hospitals which were less favored under PPS (i.e. Quartile 1) would have the most rapid outpatient cost increases.

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[1] These rates of growth are statistically significant. For example, we reject the hypothesis (with t=30.6695) that the difference between Quartiles 1 and 4 (5,801 and 4,333) in the level of HOIRDIS for PPS3 is zero.

What actually happened to outpatient costs? Our variable Hospital Outpatient Cost per Outpatient Visits (HOT) shows that baseline TEFRA costs were higher for hospitals in the lower Quartiles. For the TEFRA period costs per outpatient visit were respectively $ 26, $21, $19, and $13 per visit for Quartiles 1 through 4. This suggests that high cost hospitals tend to be high cost producers of care in both their inpatient and outpatient departments. Rates of inflation through PPS3 were respectively zero, 11, 6, and 14 percent for Quartile 1 through 4. Here, there is no clear pattern of different inflation in costs for hospitals which were under different degrees of pressure from PPS.

Financial Effects on Hospitals

In this section we examine how the PPS program affected the financial condition of hospitals. We are particularly concerned with examining how hospital financial condition was affected as PPS payment rates were adjusted during the start of the program.

The PPS program was designed with the intention of reimbursing hospitals for the average cost of treating a case which fell into a particular diagnosis related group (DRG). An individual hospital might make or lose money under PPS if its costs were significantly lower or higher than the hospital industry average. Furthermore, any hospital could expect to make money on some cases and lose money on others due to random differences in the needs of a particular patient. However, the rates were set with the intention that gains and losses on particular cases would net out to zero for the average.

The legislation which created PPS set the rates for the initial year (FY84) at a level which reflected 1981 costs which had been trended to 1984 levels based upon expected inflation in hospital input prices. The founding legislation directed HCFA to update the rates at least every four years beginning with FY86. For FY84 and FY85 there was also a statutory constraint that payments under PPS must equal the payments that would have been made if the program had not been enacted. This requirement is commonly called "budget neutrality".

In subsequent legislation and regulations, various adjustments were made to the PPS rates and the updating methodology. The basic notion for updating was that rates should be adjusted annually for changes in HCFA's market basket index of hospital input prices plus or minus a discretionary adjustment factor (DAF) which would take account of changes in hospital productivity, technological and scientific advances, quality of health care, and long term cost effectiveness of services. Congress first set the DAF at 1 percentage point. Later (deficit Reduction Act of 1984) Congress reduced the DAF to one-quarter of a percentage point (0.25) to be added to FY85 rates and to not more than 0.025 percent to be added to FY86 rates. Adjustments were also to be made for error in the previous year's forecast of inflation.

In setting the initial rates for FY84, HCFA anticipated that changes in medical coding practices ("DRG creep") would result from PPS even though the actual complexity of hospital casemix would not change. These changes were expected to cause an index of hospital casemix to be 3.4 percent higher than they it would have been in the absence of changes in coding practices. To assure budget neutrality, HCFA consequently calibrated the PPS rates to offset this expected change in coding practices. However, subsequent experience showed that casemix complexity had increased by 8.4 percent.[1]

The adverse experience with coding practice changes, and further pressures to restrain the Federal deficit, encouraged Congress and the Administration to restrain the update factor. Reductions in Medicare Length of Stay observed during the first year of PPS also encouraged Congress to set the DAF to reflect the cost savings achieved by shorter stays. As a consequence, changes in the costs of hospital inputs were not matched by changes in the update factor in FY86 through FY88. The following table shows how the update factor adopted by Congress differed from the rate of increase in the hospital market basket.

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[1] One study found that 6.2 percentage point of this change was due to changes in coding practices and documentation while the remaining 2.2 points was due to changes in medical practices. Grace M. Carter and Paul B. Ginsberg, "The Medicare Case Mix Index Increase: Medical Practice Changes, Aging, and DRG Creep" (RAND Corporation, Santa Monica CA, no date.)

PPS Update Factor and the Annual Percentage Increase in HCFA's Market Basket of Hospital Input Prices, FY85 to FY88

Fiscal Year	Update Factor	Market Basket Increase
85	6.25	6.00
86	0.00	4.85
87	-0.06	4.00 to 4.6*
88	0.75	4.70

Source: Federal Register August 31, 1984 and various annual reports of ProPAC.

*The range on the market basket increase for FY87 reflects various technical disputes and adjustments in methodology.

In a subsequent audit of a sample of 2,099 Medicare participating hospitals, the HHS Inspector General also found that these hospitals had earned average profit margins of 15 percent (defined as [Medicare Inpatient Revenue - Medicare Inpatient Cost] /Medicare Inpatient Revenue). The IG concluded that HCFA had miscalculated the PPS base rates by using unaudited data which included overstated operating costs and some items of capital cost. These findings basically coincided with a General Accounting Office study which had found that the use of unaudited hospital cost data had resulted in overstatement of the PPS rates.[1] These findings were another factor encouraging the government to severely limit any update factors for the PPS rates.

In this section, we examine how the financial condition of hospitals changed under PPS. In the preceding sections of this report, we have seen how hospital length of stay fell and how the rate of increase in cost per discharge was reduced during the first year of PPS. One might expect that hospitals would have fared well financially during the first years of PPS due to the combined effects of DRG creep and reductions in length of stay. Favorable conditions would also be expected in the second year since the update factor for FY85 allowed for the full increase in the hospital market basket and no substantial adjustment was made to correct for DRG creep. However, in PPS2 hospitals did not achieve further reductions in length of stay so any favorable effects on hospital margins must have come from revenue increases rather than from cost decreases. The third year of PPS should have been less favorable to hospitals since increases in input prices were not matched by the update factor and no further reductions in length of stay were being achieved.

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[1] USDHHS, Office of the Inspector General, "Financial Impact of the Prospective Payment System on Medicare Participating Hospitals - 1984", May 30, 1986 Audit Control No. 09-62021.

USDHHS, Office of the Inspector General, "Financial Impact of the Prospective Payment System on Medicare Participating Hospitals in the State of California- 1984 " July 11, 1986 Audit Control No. 09-62025.

U.S. General Accounting Office, "Use of Unaudited Hospital Cost Data Resulted in Overstatement of Medicare's Prospective Payment System Rates" (GAO/HRD-85-74, July 15, 1985).

To measure financial condition, we computed several common financial ratios:

Medicare Margin per Discharge
= (Medicare Inpatient Hospital Payments - Medicare Inpatient Cost)
/Medicare Discharges

This ratio measures the margin between Medicare payments and costs per discharge for hospital inpatients. Additional payments received from patients for deductibles and coinsurance are not considered. As this margin becomes small or moves into negative values, a hospital becomes more dependent upon success in collecting bill from its Medicare patients.

Total Margin = (Net Patient Revenue + Non Patient Revenue
- Operating Expense - Non Operating Expense)
/(Net Patient Rev + Non Patient Rev)

Operating Margin = (Net Patient Revenue - Operating Expenses)
/Net Patient Revenue

These ratios are each measures of hospital profitability. Increases in the ratios are favorable.

Total Debt Ratio = Current Liabilities + Long Term Liabilities/Assets

This is a measures of indebtedness. In general, increases in this ratio should be viewed as unfavorable. However, increases from previous low levels may reflect improved capacity to attract financing.

Equity = Fund balances/Assets

This is sometimes called the Equity Financing Ratio. Increases in this ratio are favorable.

Liquidity = Current Assets/Current Liabilities

This is commonly known as the Current Ratio. Increases in the liquidity ratio are desirable, although unusually high levels of liquidity would indicate poor cash management.

Net Profit or Loss per Discharge = Net Profit or Loss/Total Patient Discharges

This is a "bottom line" measure of hospital profitability. Increases in the ratio are favorable to the hospital.

Let us first consider what the Medicare Margin tells us about the financial condition of hospitals under PPS. Medicare Margin is the difference between two ratios which we have previously examined in Table 3, namely Medicare Hospital Only Revenue per Discharge (MHOIRDIS) and Medicare Hospital Only Cost per Discharge (MHOICDIS).[1] As discussed previously, Medicare revenue showed gains in PPS1 of 9 to 11 percent across the various hospital quartiles. Revenue growth was slower in PPS2 (4.5 to 8.5 percent) and almost flat in PPS3 (less than 1 to almost 3 percent) for the various quartiles. In contrast, Medicare costs in PPS1 declined for hospitals in the lowest quartile and barely grew for hospitals in the other quartiles. During PPS2 costs grew by about 9 percent for all quartiles and for PPS3 costs grew by about 7 percent for all quartiles.

Examination of the Medicare Margin highlights the differences between these movements in Medicare revenues and costs. Values of the margin are shown in Table 4 and illustrated in Figure 5. The large changes which we observe in the margin reflect the discrepancy between the Medicare update factor and changes in hospital input prices. Hospitals with the least favorable prospects in Quartile 1 experienced the most volatile change over the PPS period while those in Quartile 4 with the most favorable prospects had not as much change in margin from year to year.

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[1] The values of Medicare Margin as reported in Table 4 do not necessarily equal the difference between corresponding values of MHOIRDIS and MHOICDIS as reported in Table 3. This happens because the tables report regression coefficients in linear regression which control for other factors.

Table 4. Hospital Financial Ratios for TEFRA through PPS3 by GAIN Quartile

GAIN Quartile	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
						Growth (PPSx/TEFRA)		
Medicare Margin/Discharge						$\bar{R}^2$=.22	N=11,615	
1	-236	257	74	-236*	NA	NA	NA	NA
2	-151	178	94	-127	NA	NA	NA	NA
3	-84	155	129	-85	NA	NA	NA	NA
4	-11	177	156	-53	NA	NA	NA	NA
Total Margin = (Net Patient Revenue + Non Patient Revenue - (Operating Expense + Non Operating Expense)) /(Net Pat Rev + Non Pat Rev)						$\bar{R}^2$=.08	N=11,615	
1	0.08	0.11	0.09	0.07	1.00	1.35	1.15	0.92
2	0.10	0.12	0.10	0.09	1.00	1.23	0.96	0.87
3	0.09	0.13	0.12	0.09	1.00	1.35	1.23	0.98
4	0.11	0.14	0.12	0.09	1.00	1.23	1.05	0.79
Operating Margin = (Net Patient Revenue - Operating Expenses)/Net Patient Revenue						$\bar{R}^2$=.13	N=9,558	
1	0.085	0.113	0.085*	0.085*	1.00	1.33	1.00	1.00
2	0.085*	0.122	0.085*	0.085*	1.00	1.44	1.00	1.00
3	0.085*	0.128	0.110	0.085*	1.00	1.51	1.29	1.00
4	0.104	0.142	0.115	0.100	1.00	1.36	1.10	0.96
Total Debt Ratio = Current Liabilities + Long Term Liabilities/Assets						$\bar{R}^2$=.12	N=8717.00	
1	0.53	0.52	0.54	0.55	1.00	0.99	1.01	1.03
2	0.49	0.47	0.49	0.49	1.00	0.94	0.99	0.99
3	0.48	0.47	0.47	0.49	1.00	0.98	0.98	1.02
4	0.40	0.40	0.41	0.42	1.00	1.00	1.04	1.05
Equity = Fund balances/Assets		Equity				$\bar{R}^2$=.11	N=9319	
1	0.446	0.480	0.477	0.483	1.00	1.08	1.07	1.08
2	0.479	0.520	0.511	0.509	1.00	1.09	1.07	1.06
3	0.486	0.520	0.521	0.506	1.00	1.07	1.07	1.04
4	0.519	0.548	0.545	0.530	1.00	1.06	1.05	1.02
Liquidity = Current Assets/ Current Liabilities						$\bar{R}^2$=.04	N=9319	
1	1.975	2.127	2.160	2.161	1.00	1.08	1.09	1.09
2	2.131	2.243	2.237	2.236	1.00	1.05	1.05	1.05
3	2.193	2.276	2.341	2.276	1.00	1.04	1.07	1.04
4	2.302	2.488	2.501	2.347	1.00	1.08	1.09	1.02

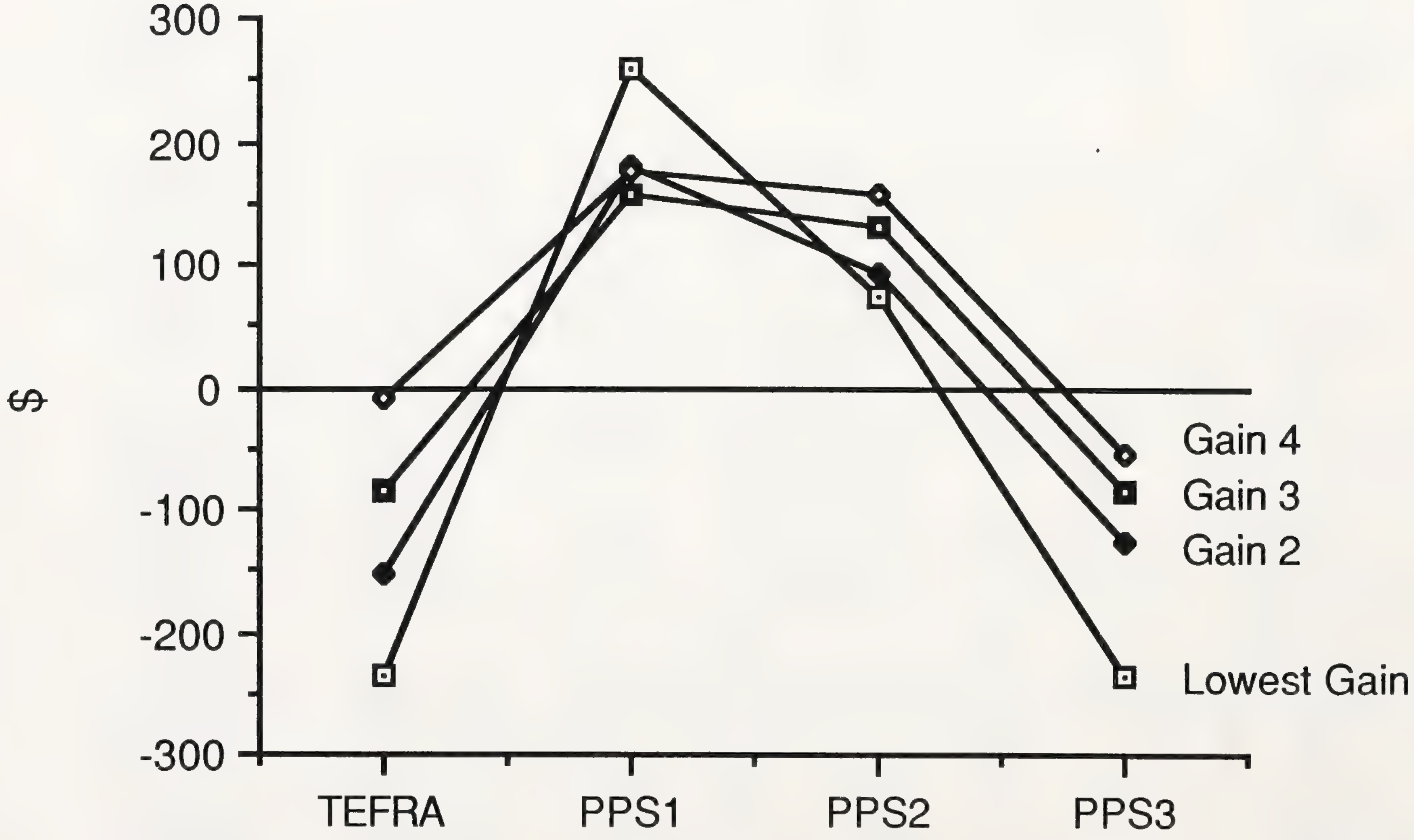
Table 4 (continued)

	TEFRA	PPS1	PPS2	PPS3	TEFRA	PPS1	PPS2	PPS3
Net Profit or Loss/Discharge						$\bar{R}^2$=.09	N=11,615	
1	406	538	469	406*	1.00	1.33	1.16	1.00
2	406*	532	457	406*	1.00	1.20	1.03	1.00
3	406*	532	509	406*	1.00	1.25	1.20	1.00
4	406*	537	494	406*	1.00	1.22	1.12	1.00

* Incremental value for this observation is not significantly different from baseline TEFRA, Quartile 1 at the 5 percent level of confidence

Figure 5

Medicare Margin per Discharge



During PPS1, Medicare Margin per Discharge rose strongly changing from negative to positive values for every quartiles. For Quartiles 1 and 4 respectively, the margins changed from $-236 to $257 and from $-11 to $177. These results are generally consistent with findings of the HHS Inspector General that hospitals tended to profit from PPS during the program's first year.

For PPS2, the Medicare Margin begins to decline. For Quartiles 1 through 4 it drops by $ 183 (71 percent), $84 (47 percent), $26 (17 percent) and $21 (12 percent) respectively.

Medicare Margin per Discharge fell in PPS3 to negative levels which are similar to TEFRA levels. (They would be lower than TEFRA if we adjusted for inflation.) For Quartile 1 and 3, TEFRA and PPS3 levels were nearly identical as shown by Figure 5. For Quartile 3, the Medicare Margin was more negative under TEFRA than under PPS3 ($-151 vs. $-127) while for Quartile 4 the margin under PPS3 ($-53) was worse than under TEFRA ($-11). Thus, under PPS3, hospitals returned to a situation where successful collection of coinsurance and deductibles was important to avoid losing money on a discharge; under PPS1 and PP2, in contrast the margin had been large and positive so that successful collection was not as pressing a concern.

The other financial ratios shown in Table 4 also confirm the story which is suggested by the movements in Medicare Margin. During the TEFRA period, hospitals in Quartile 1, which could expect to do poorly under PPS, tended to already be in worse condition in terms of several ratios than hospitals in Quartile 4, which could expect to do well under PPS. This is the case (Quartile 1 vs. Quartile 4) for the ratios for Total Margin (0.08 vs. 0.11), Operating Margin (0.085 vs. 0.104), Total Debt(.53 vs. .40), Liquidity (1.975 vs. 2.302), and Equity (0.446 vs. 0.519). During TEFRA There is no statistically significant difference among the four quartiles in Net Profit or Loss per Discharge ($406).

During the PPS1 period, hospitals tended to see an improvement in their financial ratios. There is a mixed pattern as to whether hospitals in the lower quartiles (1 and 2) did relatively better or worse than hospitals in the upper quartiles (3 and 4), but the ratios either stayed steady or moved in directions favorable to the hospitals. For example, Total Margin rose by 23 percent (Quartiles 2 and 4) to 35 percent (Quartile 1 and 3), Operating Margin rose by at least 33 percent for all quartiles, Total Debt remained unchanged for Quartile 4 and fell by 1 to 6 percent for the other quartiles, Liquidity rose by 4 percent (Quartile 3) to 8 percent (Quartiles 1 and 4), Equity rose by 6 percent (Quartile 4) to 9 percent (Quartile 2), and Net Profit per Discharge rose by 20 percent (Quartile 2) to 33 percent (Quartile 1).

These initial favorable effects toward hospitals tended to wear off by the time of PPS3. The pattern again is mixed in terms of which hospital quartile does relatively better or worse for a particular ratio but the general trend is to move away from favorable values in the PPS1 and PPS2 years to conditions nearer to TEFRA.

Total Margin fell to PPS3 values which were 8 percent (Quartile 1) to 21 percent (Quartile 4) below TEFRA levels. Operating Margin fell to TEFRA levels for Quartiles 1,2 and 3 and fell 4 percent below the TEFRA level for Quartile 4. The Total Debt Ratio was down 1 percent for Quartile 2 but up by 2 percent (Quartile 3) to 5 percent (Quartile 4) for the other quartiles.

Some favorable financial results remained in PPS3. Gains in the Equity ratio were partly retained. Equity ratios for PPS3 were 2 percent (Quartile 4) to 8 percent (Quartile 1) above TEFRA values. Likewise, Liquidity ratios remained above TEFRA levels by 2 percent (Quartile 4) to 9 percent (Quartile 1).

Like the Medicare Margin, Net Profit per Discharge declined in PPS3 for all quartiles to levels which were statistically indistinguishable from TEFRA levels.

In summary, hospitals experienced a financial roller coaster ride during the early years of PPS. At the start of PPS hospitals benefited. They cut their length of stay and thus reduced cost. Attention to medical coding also improved their revenues beyond levels that had been forecast by HCFA in setting the PPS rates. The update of the PPS rates in FY85 basically kept pace with inflation in input prices. In later years, however, hospitals found their costs to be growing more rapidly than their revenue as Congress tried to recoup some of the revenues generated by DRG creep. At the same time, no further substantial reductions were achieved in length of stay.

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                                                   SAS                              12:58 WEDNESDAY, OCTOBER 12, 1988   11

DEP VARIABLE: INPTOUT  INPAT DAYS/OUTPAT DAYS

                     SUM OF         MEAN
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ERROR   11345        151365    13.342037
C TOTAL11381         162466

    ROOT MSE       3.652675     R-SQUARE       0.0683
    DEP MEAN       2.141657     ADJ R-SQ       0.0654
    C.V.           170.5537

                  PARAMETER     STANDARD   T FOR H0:                                         STANDARDIZED                 VARIANCE
VARIABLE   DF      ESTIMATE        ERROR PARAMETER=0    PROB > |T|    TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE   INFLATION

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JALYR11     1     -0.317155     0.187655      -1.690        0.0910    35.475367    38.110442    -0.021006     0.531599    1.881117
JALYR12     1     -0.618057     0.188389      -3.281        0.0010      216.832      143.605    -0.040636     0.535279    1.868186
JALYR13     1     -0.765353     0.218549      -3.502        0.0005      184.493      163.625    -0.039307     0.651854    1.534085
JALYR20     1     -0.017666     0.187950      -0.094        0.9251     6.188573     0.117874    -0.001174     0.526101    1.900775
JALYR21     1     -0.270167     0.188192      -1.436        0.1511    22.877607    27.497057    -0.017916     0.527291    1.896486
JALYR22     1     -0.346910     0.187655      -1.849        0.0645    48.650987    45.597054    -0.023157     0.523347    1.910777
JALYR23     1     -0.710811     0.209713      -3.389        0.0007      167.037      153.278    -0.039176     0.614709    1.626786
JALYR30     1     -0.032972     0.188342      -0.175        0.8610    11.226930     0.408907    -0.002206     0.517068    1.933982
JALYR31     1     -0.048484     0.187305      -0.259        0.7958    15.209356     0.893961    -0.003279     0.511903    1.953495
JALYR32     1     -0.436855     0.187473      -2.330        0.0198    62.697239    72.446942    -0.029472     0.513363    1.947940
JALYR33     1     -0.660030     0.208520      -3.165        0.0016      141.074      133.676    -0.036975     0.601842    1.661565
JALYR40     1      0.101299     0.192625       0.526        0.5990      291.726     3.689848     0.006770     0.495506    2.018140
JALYR41     1     -0.282892     0.192412      -1.470        0.1415    77.111534    28.840150    -0.018929     0.495423    2.018476
JALYR42     1     -0.552292     0.191144      -2.889        0.0039    22.108039      111.388    -0.037476     0.488159    2.048512
JALYR43     1     -1.034606     0.209007      -4.950        0.0001    70.447147      326.926    -0.059379     0.570719    1.752174
PROPDUM     1      0.409449     0.114419       3.579        0.0003      394.072      170.854     0.035909     0.815562    1.226148
NEEDDUM     1     -0.504277     0.085666      -5.887        0.0001     5.612735      462.317    -0.061647     0.748788    1.335491
OTEACHD     1      0.219050     0.124887       1.754        0.0795     0.097199    41.046506     0.019595     0.657975    1.519814
MAJTEACH    1     -0.724798     0.275371      -2.632        0.0085      165.610    92.431177    -0.025206     0.895475    1.116725
RURAL50     1      0.939805     0.147000       6.393        0.0001     4001.439      545.334     0.106202     0.297601    3.360199
RURAL99     1     -0.468719     0.146630      -3.197        0.0014    18.146630      136.333    -0.047262     0.375679    2.661850
RURAL169    1     -0.452116     0.164186      -2.754        0.0059    17.999222      101.169    -0.034511     0.522852    1.912587
RURAL170    1     -0.276543     0.202234      -1.367        0.1715     0.493730    24.948192    -0.014740     0.706738    1.414951
URBAN100    1      0.113189     0.159747       0.709        0.4786     9.751643     6.698337     0.009251     0.481734    2.075834
URBAN199    1     -0.218651     0.148949      -1.468        0.1421    85.294039    28.750813    -0.019043     0.488003    2.049167
URBAN404    1     -0.133905     0.178394      -0.751        0.4529     5.535809     7.517218    -0.008492     0.641588    1.558632
URBAN504    1     -0.091115     0.227470      -0.401        0.6888     1.136071     2.140674    -0.004221     0.739655    1.351982
URBAN505    1      0.382663     0.236686       1.617        0.1060      132.800    34.874440     0.017193     0.726191    1.377048
RNEWENG     1     -0.297734     0.305103      -0.976        0.3292      288.316    12.705358    -0.011927     0.549703    1.819164
RSOATL      1      0.935250     0.227655       4.108        0.0001     0.272500      225.176     0.088385     0.177419    5.636365
RNECENT     1      0.229945     0.219708       1.047        0.2953     1067.059    14.614355     0.024518     0.149637    6.682848
RSECENT     1      1.467761     0.243407       6.030        0.0001    70.457907      485.138     0.111014     0.242296    4.127185
RNWCENT     1      1.969376     0.228232       8.629        0.0001     1904.306      993.406     0.195240     0.160407    6.234138
RSWCENT     1      1.366412     0.228170       5.989        0.0001     1397.705      478.487     0.133753     0.164625    6.074403
RMOUNT      1      0.590661     0.258733       2.283        0.0225      161.510    69.533645     0.035561     0.338437    2.954763
RPACIFIC    1     -0.035626     0.230208      -0.155        0.8770     0.319530     0.319530    -0.003038     0.213087    4.692930

TEST: JIX          NUMERATOR:      171.557  DF:      1    F VALUE:     12.8584
                   DENOMINATOR:     13.342  DF:11345      PROB >F :     0.0003
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DEP VARIABLE: VTOT     TOTAL OUTPATIENT VISITS

                    SUM OF         MEAN
SOURCE     DF      SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36 115481663599   3207823989      275.267       0.0001
ERROR   11345 132209139208     11653516
C TOTAL 11381 247690802807

    ROOT MSE      3413.725     R-SQUARE       0.4662
    DEP MEAN      2629.402     ADJ R-SQ       0.4646
    C.V.          129.8289

                 PARAMETER     STANDARD   T FOR H0:                                           STANDARDIZED                  VARIANCE
VARIABLE  DF      ESTIMATE        ERROR PARAMETER=0   PROB > |T|   TYPE I SS   TYPE II SS      ESTIMATE    TOLERANCE     INFLATION

INTERCEP   1      5591.530      244.631      22.857      0.0001 78692386604   6088284128      0.000000            .      0.000000
JALYR11    1      -121.436      175.379      -0.692      0.4887   281738982      5587244     -0.006514     0.531599      1.881117
JALYR12    1     90.117993      176.065       0.512      0.6088   502931144      3053060      0.004799     0.535279      1.868186
JALYR13    1       192.700      204.252       0.943      0.3455   133257074     10372620      0.008015     0.651854      1.534085
JALYR20    1       295.894      175.654       1.685      0.0921   331684010     33068246      0.015930     0.526101      1.900775
JALYR21    1       272.621      175.881       1.550      0.1212   398214232     27998821      0.014642     0.527291      1.896486
JALYR22    1       484.533      175.379       2.763      0.0057   776635894     88950785      0.026195     0.523347      1.910777
JALYR23    1       824.898      195.994       4.209      0.0001   820744736    206429539      0.036821     0.614709      1.626786
JALYR30    1       205.108      176.021       1.165      0.2439   108466167     15823048      0.011115     0.517068      1.933982
JALYR31    1       292.081      175.052       1.669      0.0952   155025408     32443784      0.015996     0.511903      1.953495
JALYR32    1       455.308      175.209       2.599      0.0094   415671076     78696742      0.024878     0.513363      1.947940
JALYR33    1       764.765      194.879       3.924      0.0001   413118114    179466757      0.034697     0.601842      1.661565
JALYR40    1       290.859      180.024       1.616      0.1062   212899584     30420081      0.015743     0.495506      2.018140
JALYR41    1       300.500      179.825       1.671      0.0947   359873737     32541960      0.016285     0.495423      2.018476
JALYR42    1       393.267      178.640       2.201      0.0277   675374949     56477492      0.021612     0.488159      2.048512
JALYR43    1       614.593      195.334       3.146      0.0017   784693848    115365207      0.028567     0.570719      1.752174
PROPDUM    1      -345.543      106.934      -3.231      0.0012  2295694131    121682917     -0.024543     0.815562      1.226148
NEEDDUM    1       165.951    80.062268       2.073      0.0382  3962917199     50068366      0.016430     0.748788      1.335491
OTEACHD    1       783.440      116.717       6.712      0.0001 14729932832    525050318      0.056760     0.657975      1.519814
MAJTEACH   1     12523.683      257.357      48.663      0.0001 52408888830  27596161780      0.352730     0.895475      1.116725
RURAL50    1     -3078.938      137.384     -22.411      0.0001  5141804081   5853136619     -0.281788     0.297601      3.360199
RURAL99    1     -2430.314      137.038     -17.735      0.0001  3862779595   3665228167     -0.198467     0.375679      2.661850
RURAL169   1     -1449.009      153.446      -9.443      0.0001   795204843   1039180180     -0.089578     0.522852      1.912587
RURAL170   1     99.532929      189.004       0.527      0.5985    24442915      3231821      0.004297     0.706738      1.414951
URBAN100   1     -2717.093      149.296     -18.199      0.0001  5157522327   3859820914     -0.179856     0.481734      2.075834
URBAN199   1     -1362.079      139.205      -9.785      0.0001  5563670420   1115707966     -0.096075     0.488003      2.049167
URBAN404   1      1555.778      166.724       9.331      0.0001    51601569   1014746387      0.079909     0.641588      1.558632
URBAN504   1      2780.167      212.590      13.078      0.0001   160414830   1993035965      0.104301     0.739655      1.351982
URBAN505   1      6688.577      221.203      30.237      0.0001  9173133848  10654738314      0.243383     0.726191      1.377048
RNEWENG    1      -766.203      285.143      -2.687      0.0072   424085449     84143064     -0.024859     0.549703      1.819164
RSOATL     1     -2686.645      212.762     -12.627      0.0001   281343255   1858178769     -0.205631     0.177419      5.636365
RNECENT    1     -1560.998      205.335      -7.602      0.0001   778879378    673498401     -0.134801     0.149637      6.682848
RSECENT    1     -2980.107      227.484     -13.100      0.0001   244317422   1999948077     -0.182550     0.242296      4.127185
RNWCENT    1     -2729.477      213.301     -12.796      0.0001   387762187   1908219691     -0.219153     0.160407      6.234138
RSWCENT    1     -3074.364      213.243     -14.417      0.0001  2778812808   2422241111     -0.243728     0.164625      6.074403
RMOUNT     1     -2107.908      241.807      -8.717      0.0001   468549934    885568451     -0.102782     0.338437      2.954763
RPACIFIC   1     -1290.967      215.148      -6.000      0.0001   419576793    419576793     -0.089161     0.213087      4.692930

TEST: J1X         NUMERATOR:     1545014  DF:     1   F VALUE:    0.1326
                  DENOMINATOR:  11653516  DF:11345   PROB >F :   0.7158
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DEP VARIABLE: HLOS     TOTAL LOS

                  SUM OF         MEAN
SOURCE      DF   SQUARES       SQUARE       F VALUE       PROB>F

MODEL       36   6836.284      189.897       98.390       0.0001
ERROR    11579  22348.058     1.930051
C TOTAL11615    29184.342

    ROOT MSE     1.389263     R-SQUARE       0.2342
    DEP MEAN     5.575217     ADJ R-SQ       0.2319
    C.V.         24.91854

                PARAMETER     STANDARD   T FOR H0:                                       STANDARDIZED                 VARIANCE
VARIABLE  DF     ESTIMATE        ERROR  PARAMETER=0   PROB > |T|    TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1     8.020120     0.103332       77.615       0.0001       361061    11626.762     0.000000            .     0.000000
JALYR11    1    -0.812749     0.077626      -10.470       0.0001      144.518      211.578    -0.126092     0.455979     2.193083
JALYR12    1    -0.973691     0.078981      -12.328       0.0001    58.719004      293.339    -0.145792     0.472881     2.114697
JALYR13    1    -0.883652     0.078119      -11.312       0.0001      126.743      246.953    -0.135206     0.462886     2.160361
JALYR20    1    -0.654871     0.081072       -8.078       0.0001      325.024      125.931    -0.093150     0.497299     2.010865
JALYR21    1    -1.330333     0.077120      -17.250       0.0001     0.014419      574.322    -0.210432     0.444407     2.250189
JALYR22    1    -1.436528     0.079037      -18.175       0.0001    10.008651      637.577    -0.215815     0.469050     2.131969
JALYR23    1    -1.384801     0.077420      -17.887       0.0001     3.441357      617.508    -0.217352     0.447882     2.232730
JALYR30    1    -0.897515     0.081536      -11.008       0.0001      113.183      233.856    -0.127471     0.493146     2.027795
JALYR31    1    -1.404762     0.077616      -18.099       0.0001     7.946932      632.219    -0.221546     0.441357     2.265741
JALYR32    1    -1.437307     0.079038      -18.185       0.0001    13.514079      638.264    -0.217938     0.460453     2.171773
JALYR33    1    -1.449346     0.077592      -18.679       0.0001    25.502099      673.404    -0.228577     0.441631     2.264334
JALYR40    1    -1.169819     0.081357      -14.379       0.0001     1.802486      399.035    -0.172421     0.459916     2.174308
JALYR41    1    -1.554984     0.077723      -20.007       0.0001      156.330      772.549    -0.255204     0.406443     2.460367
JALYR42    1    -1.549908     0.079484      -19.500       0.0001      289.104      733.881    -0.241941     0.429592     2.327791
JALYR43    1    -1.475134     0.078135      -18.879       0.0001      968.938      687.921    -0.239049     0.412493     2.424283
PROPDUM    1     0.057914     0.042160        1.374       0.1696     0.108040     3.642030     0.012654     0.779321     1.283167
NEEDDUM    1    -0.080864     0.032194       -2.512       0.0120      433.937    12.177006    -0.023805     0.736329     1.358088
OTEACHD    1     0.228309     0.049258        4.635       0.0001      771.436    41.463726     0.046692     0.651689     1.534474
MAJTEACH   1     0.345589     0.116531        2.966       0.0030      164.359    16.974832     0.025255     0.911964     1.096535
RURAL50    1    -0.854237     0.055784      -15.313       0.0001    36.984799      452.584    -0.237420     0.275116     3.634827
RURAL99    1    -1.205450     0.056073      -21.498       0.0001      465.921      891.985    -0.291143     0.360575     2.773350
RURAL169   1    -1.016577     0.063767      -15.942       0.0001      191.728      490.527    -0.178913     0.525085     1.904452
RURAL170   1    -0.511187     0.078169       -6.540       0.00010.0005861959    82.539316    -0.063416     0.703258     1.421953
URBAN100   1    -0.785545     0.060670      -12.948       0.0001      486.540      323.562    -0.155873     0.456319     2.191451
URBAN199   1    -0.314788     0.057480       -5.476       0.0001      120.904    57.886179    -0.064458     0.477391     2.094719
URBAN404   1    -0.072748     0.069713       -1.044       0.2967     1.428609     2.101753    -0.010609     0.639800     1.562989
URBAN504   1    -0.072202     0.089306       -0.808       0.4188     2.909290     1.261561    -0.007656     0.737420     1.356079
URBAN505   1     0.137825     0.095557        1.442       0.1492     7.893027     4.015114     0.013680     0.735179     1.360212
RNEWENG    1    -0.225168     0.119365       -1.886       0.0593    35.257383     6.867956    -0.019748     0.603427     1.657201
RSOATL     1    -0.227885     0.084605       -2.694       0.0071      249.863    14.002684    -0.050266     0.189897     5.266008
RNECENT    1    -0.532472     0.081541       -6.530       0.0001    52.125328    82.302961    -0.133691     0.157783     6.337802
RSECENT    1    -0.348343     0.090988       -3.828       0.0001      128.152    28.288759    -0.061335     0.257661     3.881064
RNWCENT    1    -0.284708     0.084260       -3.379       0.0007      690.113    22.035747    -0.069393     0.156801     6.377500
RSWCENT    1    -0.795319     0.084165       -9.450       0.0001      185.671      172.343    -0.194235     0.156527     6.388687
RMOUNT     1    -1.455140     0.098849      -14.721       0.0001    38.570644      418.248    -0.194637     0.378295     2.643437
RPACIFIC   1    -1.431013     0.086552      -16.534       0.0001      527.595      527.595    -0.285099     0.222413     4.496148

TEST: J1X        NUMERATOR:     351.841  DF:     1   F VALUE:   182.2965
                 DENOMINATOR:   1.93005  DF:11579   PROB >F :    0.0001
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Regressions for Table 1

```
DEP VARIABLE: ALTGAINL ALTERNATIVE LONG RUN GAIN

                     SUM OF         MEAN
SOURCE    DF        SQUARES       SQUARE      F VALUE       PROB>F

MODEL     21      30.920581     1.472409      175.995       0.0001
ERROR  13618        113.931  0.008366214
C TOTAL13639        144.852

    ROOT MSE       0.091467     R-SQUARE       0.2135
    DEP MEAN       0.049588     ADJ R-SQ       0.2123
    C.V.           184.4548

                  PARAMETER     STANDARD    T FOR H0:                                            STANDARDIZED                  VARIANCE
VARIABLE  DF       ESTIMATE        ERROR  PARAMETER=0   PROB > |T|   TYPE I SS   TYPE II SS      ESTIMATE    TOLERANCE    INFLATION

INTERCEP  1       0.019973  0.004961879        4.025       0.0001   33.540012     0.135552     0.000000      .           0.000000
PROPDUM   1      -0.034583  0.002527687      -13.682       0.0001    0.538720     1.566053    -0.115840     0.805693     1.241168
NEEDDUM   1    0.005529705  0.001961207        2.820       0.0048    3.780152     0.066510     0.024866     0.742574     1.346667
OTEACHD   1      -0.013655     0.002881       -4.740       0.0001    2.732351     0.187949    -0.044227     0.663338     1.507528
MAJTEACH  1    -0.00274064  0.006230489       -0.440       0.6600    0.424579  0.001618782    -0.003539     0.892183     1.120847
RURAL50   1       0.064074  0.003311625       19.348       0.0001    3.587560     3.131938     0.271230     0.293910     3.402400
RURAL99   1       0.014533  0.003386557        4.291       0.0001    0.030558     0.154080     0.053059     0.377837     2.646645
RURAL169  1    -0.00585452  0.003831957       -1.528       0.1266    0.879128     0.019529    -0.015885     0.534315     1.871553
RURAL170  1    0.001198962  0.004723741        0.254       0.7996    0.115608 0.0005389737     0.002283     0.714076     1.400411
URBAN100  1       0.095306  0.003550504       26.843       0.0001    6.741388     6.028241     0.293350     0.483609     2.067787
URBAN199  1       0.018371  0.003417508        5.376       0.0001    0.235784     0.241754     0.058494     0.487775     2.050124
URBAN404  1    0.003102902  0.004152437        0.747       0.4549    0.031651  0.004671528     0.007075     0.644291     1.552093
URBAN504  1    -0.00821398  0.005328515       -1.542       0.12320.0003193941     0.019880    -0.013594     0.742703     1.346434
URBAN505  1      -0.011826  0.005548465       -2.131       0.0331 0.003423119     0.038009    -0.018959     0.730052     1.369766
RNEWENG   1      -0.029137  0.006972163       -4.179       0.0001    0.207713     0.146109    -0.040371     0.618890     1.615796
RSOATL    1       0.027868  0.004905053        5.682       0.0001    1.132450     0.270060     0.094110     0.210504     4.750504
RNECENT   1      -0.020368  0.004703235       -4.331       0.0001    1.167359     0.156906    -0.078787     0.174504     5.730523
RSECENT   1       0.058222  0.005262462       11.064       0.0001    3.289312     1.024066     0.159311     0.278554     3.589964
RNWCENT   1    -0.00429827  0.004915966       -0.874       0.3819    0.043018  0.006395867    -0.015444     0.185115     5.402061
RSWCENT   1       0.034576  0.004878231        7.088       0.0001    5.134005     0.420286     0.127317     0.178998     5.586666
RMOUNT    1      -0.014916  0.005648651       -2.641       0.0083    0.200735     0.058339    -0.032724     0.376093     2.658914
RPACIFIC  1      -0.043155  0.004915856       -8.779       0.0001    0.644767     0.644767    -0.139603     0.228396     4.378358

COLLINEARITY DIAGNOSTICS        VARIANCE PROPORTIONS

                    CONDITION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION  PORTION
NUMBER EIGENVALUE       INDEX INTERCEP  PROPDUM  NEEDDUM  OTEACHD MAJTEACH  RURAL50  RURAL99 RURAL169 RURAL170 URBAN100 URBAN199

     1        3.604      1.000   0.0018   0.0093   0.0166   0.0067   0.0021   0.0046   0.0041   0.0029   0.0019   0.0037   0.0038
     2        1.711      1.451   0.0000   0.0022   0.0316   0.0766   0.0087   0.0198   0.0036   0.0006   0.0017   0.0009   0.0086
     3        1.465      1.568   0.0000   0.1139   0.0087   0.0218   0.0174   0.0046   0.0005   0.0005   0.0010   0.0395   0.0256
     4        1.245      1.701   0.0000   0.0007   0.0000   0.0044   0.0104   0.0181   0.0426   0.0358   0.0444   0.0116   0.0033
     5        1.087      1.821   0.0001   0.0000   0.0070   0.0044   0.0947   0.0031   0.0161   0.0183   0.0113   0.0061   0.0021
     6        1.077      1.829   0.0000   0.0041   0.0018   0.0142   0.1749   0.0000   0.0126   0.0149   0.0005   0.0373   0.0143
     7        1.037      1.865   0.0000   0.0004   0.0010   0.0050   0.1388   0.0000   0.0034   0.0260   0.1409   0.0221   0.0319
     8        1.019      1.880   0.0000   0.0053   0.0043   0.0034   0.0002   0.0046   0.0388   0.0078   0.0947   0.0020   0.0017
     9        1.010      1.889   0.0000   0.0013   0.0001   0.0050   0.0094   0.0011   0.0020   0.1044   0.0382   0.0335   0.0387
    10        1.001      1.897   0.0000   0.0010   0.0004   0.0021   0.0108   0.0000   0.0034   0.0029   0.0387   0.0049   0.0127
    11     0.995172      1.903   0.0000   0.0015   0.0001   0.0000   0.0021   0.0006   0.0088   0.0856   0.0331   0.0343   0.0666
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Appendix

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DEP VARIABLE: V053     TOTAL DISCHARGES: HOSPITAL

                        SUM OF          MEAN
SOURCE      DF         SQUARES        SQUARE       F VALUE       PROB>F

MODEL       36      2883467811      80096328      2336.039       0.0001
ERROR    13768       472066754     34287.242
C TOTAL  13804      3355534565

      ROOT MSE         185.168      R-SQUARE        0.8593
      DEP MEAN         430.081      ADJ R-SQ        0.8589
      C.V.            43.05422

                     PARAMETER      STANDARD    T FOR H0:                                          STANDARDIZED                  VARIANCE
VARIABLE    DF        ESTIMATE         ERROR  PARAMETER=0    PROB > |T|   TYPE I SS   TYPE II SS       ESTIMATE    TOLERANCE     INFLATION

INTERCEP     1         728.316     11.700218       62.248        0.0001  2553509511    132857025       0.000000            .      0.000000
JALYR11      1      -24.102248      9.073205       -2.656        0.0079     8476806       241950      -0.011634     0.532701      1.877225
JALYR12      1      -43.102412      9.067750       -4.753        0.0001     6441795       774705      -0.020829     0.532145      1.879185
JALYR13      1      -59.170637      9.062308       -6.529        0.0001     5174331      1461731      -0.028626     0.531592      1.881141
JALYR20      1       72.521564      9.047645        8.016        0.0001    16063983      2202905       0.035436     0.522801      1.912772
JALYR21      1       48.071896      9.050176        5.312        0.0001    13063198       967389       0.023477     0.523081      1.911749
JALYR22      1       33.007745      9.045003        3.649        0.0003    12039715       456612       0.016137     0.522535      1.913746
JALYR23      1       17.352775      9.045003        1.918        0.0551    11193380       126198       0.008484     0.522535      1.913746
JALYR30      1       73.416126      9.057325        8.106        0.0001     9002480      2252764       0.036127     0.514379      1.944093
JALYR31      1       49.200812      9.062633        5.429        0.0001     6594173      1010574       0.024185     0.514884      1.942183
JALYR32      1       34.161223      9.059545        3.771        0.0002     6551216       487513       0.016801     0.514680      1.942953
JALYR33      1       17.594904      9.057325        1.943        0.0521     6129930       129392       0.008658     0.514379      1.944093
JALYR40      1       50.687353      9.168747        5.528        0.0001      704437      1047881       0.025354     0.485789      2.058508
JALYR41      1       27.001384      9.168747        2.945        0.0032     3653850       297361       0.013506     0.485789      2.058508
JALYR42      1        9.921802      9.177234        1.081        0.2797    11317301    40076.526       0.004955     0.486403      2.055909
JALYR43      1       -4.648197      9.173905       -0.507        0.6124    43436628     8802.236      -0.002323     0.486250      2.056554
PROPDUM      1      -51.245558      5.122051      -10.005        0.0001    25836716      3432078      -0.035975     0.790298      1.265345
NEEDDUM      1       -7.683509      3.949656       -1.945        0.0518   171526615       129758      -0.007218     0.742197      1.347351
OTEACHD      1       46.829128      5.817017        8.050        0.0001   547925168      2222103       0.031702     0.658897      1.517688
MAJTEACH     1         285.180     12.517159       22.783        0.0001   295705272     17797501       0.077133     0.891493      1.121714
RURAL50      1        -689.118      6.748763     -102.110        0.0001   238905791    357496375      -0.609950     0.286366      3.492031
RURAL99      1        -563.616      6.829283      -82.529        0.0001   176490703    233533299      -0.430014     0.376376      2.656915
RURAL169     1        -352.947      7.720734      -45.714        0.0001    26393744     71653065      -0.200078     0.533424      1.874683
RURAL170     1      -24.982057      9.553371       -2.615        0.0089     3843383       234464      -0.009893     0.713888      1.400781
URBAN100     1        -595.405      7.287554      -81.702        0.0001   324436980    228872549      -0.383943     0.462699      2.161233
URBAN199     1        -338.466      6.891514      -49.113        0.0001   372035102     82705430      -0.225478     0.484803      2.062693
URBAN404     1         303.150      8.382294       36.165        0.0001     2298027     44845678       0.144088     0.643730      1.553446
URBAN504     1         616.904     10.707601       57.614        0.0001    21505455    113810822       0.213914     0.741213      1.349140
URBAN505     1        1351.302     11.189710      120.763        0.0001   504135773    500034014       0.452431     0.728002      1.373623
RNEWENG      1       12.711579     14.074452        0.903        0.3665    2720.033    27968.462       0.003660     0.622270      1,607020
RSOATL       1       31.545338      9.860435        3.199        0.0014      225370       350922       0.022193     0.212323      4.709801
RNECENT      1      -21.582831      9.441262       -2.286        0.0223     5159330       179180      -0.017468     0.175005      5.714136
RSECENT      1       44.307908     10.612661        4.175        0.0001      289743       597649       0.025281     0.278682      3.588322
RNWCENT      1       -9.038166      9.859838       -0.917        0.3593     3973385    28810.690      -0.006782     0.186673      5.356960
RSWCENT      1       31.322753      9.793660        3.198        0.0014      645719       350721       0.024149     0.179231      5.579390
RMOUNT       1       37.319999     11.351884        3.288        0.0010      280398       370578       0.017082     0.378473      2.642198
RPACIFIC     1       75.595650      9.875343        7.655        0.0001     2009193      2009193       0.051251     0.227958      4.386776

TEST: J1X         NUMERATOR:      1109958   DF:      1    F VALUE:    32.3723
                  DENOMINATOR:    34287.2   DF:13768      PROB >F :    0.0001
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DEP VARIABLE: HBED  Total Hospital Beds

                      SUM OF           MEAN
SOURCE      DF       SQUARES         SQUARE       F VALUE       PROB>F

MODEL       36     263513278        7319813      3225.377       0.0001
ERROR    13768      31245713       2269.445
C TOTAL  13804     294758991

     ROOT MSE      47.638688       R-SQUARE        0.8940
     DEP MEAN        141.886       ADJ R-SQ        0.8937
     C.V.           33.57543

                   PARAMETER       STANDARD    T FOR H0:                                                   STANDARDIZED                   VARIANCE
VARIABLE   DF       ESTIMATE          ERROR  PARAMETER=0   PROB > |T|   TYPE I SS    TYPE II SS       ESTIMATE     TOLERANCE     INFLATION

INTERCEP    1        261.495       3.010145       86.871       0.0001   277915481      17126632       0.000000             .      0.000000
JALYR11     1     -19.534988       2.334287       -8.369       0.0001     1688048        158942      -0.031816      0.532701      1.877225
JALYR12     1     -23.647256       2.332884      -10.136       0.0001     1596942        233182      -0.038557      0.532145      1.879185
JALYR13     1     -28.475632       2.331483      -12.214       0.0001     1488458        338534      -0.046481      0.531592      1.881141
JALYR20     1      -7.780851       2.327711       -3.343       0.0008     1438676     25358.042      -0.012828      0.522801      1.912772
JALYR21     1     -18.957057       2.328362       -8.142       0.0001      928879        150439      -0.031236      0.523081      1.911749
JALYR22     1     -19.639296       2.327031       -8.440       0.0001     1053093        161647      -0.032396      0.522535      1.913746
JALYR23     1     -22.138711       2.327031       -9.514       0.0001     1113164        205409      -0.036519      0.522535      1.913746
JALYR30     1     -15.703536       2.330201       -6.739       0.0001      400874        103069      -0.026073      0.514379      1.944093
JALYR31     1     -22.545319       2.331567       -9.670       0.0001      233243        212196      -0.037392      0.514884      1.942183
JALYR32     1     -24.103868       2.330773      -10.342       0.0001      279978        242713      -0.039999      0.514680      1.942953
JALYR33     1     -26.222567       2.330201      -11.253       0.0001      305508        287398      -0.043538      0.514379      1.944093
JALYR40     1     -23.050168       2.358867       -9.772       0.0001      469275        216701      -0.038902      0.485789      2.058508
JALYR41     1     -24.725001       2.358867      -10.482       0.0001      897110        249336      -0.041729      0.485789      2.058508
JALYR42     1     -25.637835       2.361051      -10.859       0.0001     1921153        267591      -0.043202      0.486403      2.055909
JALYR43     1     -26.392803       2.360194      -11.182       0.0001     6203465        283789      -0.044497      0.486250      2.056554
PROPDUM     1      -0.282785       1.317763       -0.215       0.8301     1063412       104.510      -0.000670      0.790298      1.265345
NEEDDUM     1      -2.433817       1.016138       -2.395       0.0166    16389676     13019.368      -0.007714      0.742197      1.347351
OTEACHD     1       9.845620       1:496559        6.579       0.0001    49755450     98224.116       0.022489      0.658897      1.517688
MAJTEACH    1      48.849186       3.220322       15.169       0.0001    21538480        522199       0.044578      0.891493      1.121714
RURAL50     1       -204.554       1.736272     -117.812       0.0001    21140990      31499348      -0.610881      0.286366      3.492031
RURAL99     1       -168.562       1.756987      -95.938       0.0001    15598359      20888202      -0.433916      0.376376      2.656915
RURAL169    1       -109.937       1.986333      -55.347       0.0001     2838669       6951848      -0.210272      0.533424      1.874683
RURAL170    1      -8.000808       2.457820       -3.255       0.0011      291504     24048.446      -0.010690      0.713888      1.400781
URBAN100    1       -176.018       1.874888      -93.882       0.0001    30617364      20002476      -0.382965      0.462699      2.161233
URBAN199    1     -96.858390       1.772998      -54.630       0.0001    34000055       6772949      -0.217707      0.484803      2.062693
URBAN404    1      97.210778       2.156535       45.077       0.0001      146158       4611430       0.155895      0.643730      1.553446
URBAN504    1        195.599       2.754772       71.004       0.0001     2439497      11441433       0.228842      0.741213      1.349140
URBAN505    1        412.458       2.878806      143.274       0.0001    47503832      46585816       0.465937      0.728002      1.373623
RNEWENG     1     -10.511204       3.620971       -2.903       0.0037   23689.216     19123.813      -0.010211      0.622270      1.607020
RSOATL      1       4.891386       2.536820        1.928       0.0539   53319.962      8437.314       0.011611      0.212323      4.709801
RNECENT     1      -3.690741       2.428978       -1.519       0.1287   15914.141      5239.618      -0.010078      0.175005      5.714136
RSECENT     1       2.771243       2.730347        1.015       0.3101   12461.833      2337.938       0.005335      0.278682      3.588322
RNWCENT     1      -3.224189       2.536666       -1.271       0.2037   11493.431      3666.350      -0.008163      0.186673      5.356960
RSWCENT     1       2.508572       2.519640        0.996       0.3195   33446.610      2249.550       0.006525      0.179231      5.579390
RMOUNT      1      -7.343296       2.920529       -2.514       0.0119   21142.407     14347.584      -0.011341      0.378473      2.642198
RPACIFIC    1      -1.189546       2.540655       -0.468       0.6396     497.497       497.497      -0.002721      0.227958      4.386776

TEST: J1X         NUMERATOR:      356870  DF:     1   F VALUE:  157.2499
       /          DENOMINATOR:   2269.44  DF:13768    PROB >F :   0.0001
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DEP VARIABLE: IPDTOT   TOTAL INPATIENT DAYS

                   SUM OF          MEAN
SOURCE     DF     SQUARES        SQUARE      F VALUE       PROB>F

MODEL      36 123471532702    3429764797     1711.200       0.0001
ERROR   11345  22738830943       2004304
C TOTAL11381 146210363644

    ROOT MSE     1415.735      R-SQUARE       0.8445
    DEP MEAN     3111.574      ADJ R-SQ       0.8440
    C.V.         45.49898

                  PARAMETER     STANDARD   T FOR H0:                                         STANDARDIZED                   VARIANCE
VARIABLE  DF       ESTIMATE        ERROR  PARAMETER=0    PROB > ITI   TYPE I SS    TYPE II SS    ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1       6051.285      101.453       59.646        0.0001110199332814    7130644408    0.000000            .     0.000000
JALYR11    1       -435.782    72.732913       -5.992        0.0001   725697231      71951661   -0.030426     0.531599     1.881117
JALYR12    1       -620.048    73.017278       -8.492        0.0001   500383731     144531461   -0.042974     0.535279     1.868186
JALYR13    1       -750.897    84.706974       -8.865        0.0001   141332132     157501938   -0.040652     0.651854     1.534085
JALYR20    1      71.442417    72.847132        0.981        0.3268   967174503       1927751    0.005006     0.526101     1.900775
JALYR21    1       -310.986    72.940893       -4.264        0.0001   515426832      36433584   -0.021739     0.527291     1.896486
JALYR22    1       -491.896    72.732798       -6.763        0.0001   394296052      91674807   -0.034613     0.523347     1.910777
JALYR23    1       -556.578    81.282343       -6.847        0.0001   293705677      93977212   -0.032336     0.614709     1.626786
JALYR30    1       5.746519    72.999250        0.079        0.9373   580502877     12420.426    0.000405     0.517068     1.933982
JALYR31    1       -309.216    72.597125       -4.259        0.0001   248497675      36361988   -0.022041     0.511903     1.953495
JALYR32    1       -491.776    72.662260       -6.768        0.0001   170569113      91808053   -0.034974     0.513363     1.947940
JALYR33    1       -569.824    80.819846       -7.051        0.0001    60618924      99634327   -0.033649     0.601842     1.661565
JALYR40    1       -366.217    74.659251       -4.905        0.0001   106562855      48225210   -0.025800     0.495506     2.018140
JALYR41    1       -595.181    74.576847       -7.981        0.0001   440971242     127659757   -0.041981     0.495423     2.018476
JALYR42    1       -715.724    74.085147       -9.661        0.0001  1355303952     187065115   -0.051195     0.488159     2.048512
JALYR43    1       -802.750    81.008766       -9.909        0.0001  2490643811     196815728   -0.048566     0.570719     1.752174
PROPDUM    1       -410.763    44.347529       -9.262        0.0001  1434847769     171952432   -0.037974     0.815562     1.226148
NEEDDUM    1       -124.342    33.203297       -3.745        0.0002  7543393783      28108542   -0.016023     0.748788     1.335491
OTEACHD    1        601.780    48.404650       12.432        0.0001 26372044342     309788582    0.056746     0.657975     1.519814
MAJTEACH   1       2406.133      106.731       22.544        0.0001 12559065603    1018647667    0.088206     0.895475     1.116725
RURAL50    1      -4315.401    56.975541      -75.741        0.0001  5786488049   11498176256   -0.514053     0.297601     3.360199
RURAL99    1      -3894.796    56.832106      -68.532        0.0001  6829554441    9413377047   -0.413976     0.375679     2.661850
RURAL169   1      -2759.142    63.636692      -43.358        0.0001  1842996990    3767874928   -0.222009     0.522852     1.912587
RURAL170   1       -418.488    78.383560       -5.339        0.0001    46880913      57132101   -0.023514     0.706738     1.414951
URBAN100   1      -3871.968    61.915989      -62.536        0.0001 11059321585    7838294479   -0.333594     0.481734     2.075834
URBAN199   1      -2418.489    57.730980      -41.892        0.0001 15924240560    3517497941   -0.222033     0.488003     2.049167
URBAN404   1       1897.493    69.143394       27.443        0.0001   306449354    1509464244    0.126851     0.641588     1.558632
URBAN504   1       4422.471    88.164791       50.161        0.0001   848511982    5043165293    0.215947     0.739655     1.351982
URBAN505   1       9909.159    91.736922      108.017        0.0001 23622643216   23385618044    0.469310     0.726191     1.377048
RNEWENG    1       -479.783      118.254       -4.057        0.0001     1356211      32992927   -0.020261     0.549703     1.819164
RSOATL     1       -205.820    88.236525       -2.333        0.0197    77258093      10905445   -0.020504     0.177419     5.636365
RNECENT    1       -540.797    85.156121       -6.351        0.0001    33821498      80835161   -0.060784     0.149637     6.682848
RSECENT    1       -288.192    94.341847       -3.055        0.0023    19186219      18703283   -0.022977     0.242296     4.127185
RNWCENT    1       -264.673    88.460037       -2.992        0.0028    72454107      17942671   -0.027659     0.160407     6.234138
RSWCENT    1       -612.628    88.435864       -6.927        0.0001    37105103      96183383   -0.063214     0.164625     6.074403
RMOUNT     1       -531.077      100.282       -5.296        0.0001    11442128      56212657   -0.033705     0.338437     2.954763
RPACIFIC   1       -449.131    89.225935       -5.034        0.0001    50784150      50784150   -0.040374     0.213087     4.692930

TEST: JIX          NUMERATOR:     1.9E+08  DF:     1   F VALUE:    96.6150
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DEP VARIABLE: HMLOS     TOTAL MEDICARE LOS

                    SUM OF         MEAN
SOURCE      DF     SQUARES       SQUARE      F VALUE       PROB>F

MODEL       36   23663.466      657.318      541.513       0.0001
ERROR    11579   14055.232     1.213855
C TOTAL  11615   37718.697

    ROOT MSE      1.101751     R-SQUARE       0.6274
    DEP MEAN      7.177066     ADJ R-SQ       0.6262
    C.V.          15.35099

                  PARAMETER     STANDARD    T FOR H0:                                               STANDARDIZED                   VARIANCE
VARIABLE   DF      ESTIMATE        ERROR  PARAMETER=0   PROB > |T|    TYPE I SS    TYPE II SS      ESTIMATE     TOLERANCE     INFLATION

INTERCEP    1     11.266835     0.081947      137.489      0.0001        598343     22945.676      0.000000         .          0.000000
JALYR11     1     -1.671226     0.061561      -27.148      0.0001       229.452       894.599     -0.228067      0.455979      2.193083
JALYR12     1     -1.744134     0.062635      -27.846      0.0001       161.304       941.211     -0.229715      0.472881      2.114697
JALYR13     1     -1.690824     0.061952      -27.292      0.0001       273.856       904.168     -0.227567      0.462886      2.160361
JALYR20     1     -0.758839     0.064294      -11.803      0.0001      1547.503       169.091     -0.094945      0.497299      2.010865
JALYR21     1     -2.137595     0.061160      -34.951      0.0001     21.902453      1482.810     -0.297423      0.444407      2.250189
JALYR22     1     -2.255473     0.062680      -35.984      0.0001      1.501394      1571.735     -0.298059      0.469050      2.131969
JALYR23     1     -2.199652     0.061397      -35.826      0.0001     12.997793      1558.029     -0.303688      0.447882      2.232730
JALYR30     1     -1.090807     0.064662      -16.869      0.0001       782.359       345.431     -0.136274      0.493146      2.027795
JALYR31     1     -2.323225     0.061553      -37.743      0.0001      3.217458      1729.198     -0.322292      0.441357      2.265741
JALYR32     1     -2.390817     0.062681      -38.143      0.0001     13.149536      1766.014     -0.318879      0.460453      2.171773
JALYR33     1     -2.399561     0.061534      -38.995      0.0001     19.119189      1845.845     -0.332881      0.441631      2.264334
JALYR40     1     -1.554520     0.064520      -24.093      0.0001       121.786       704.638     -0.201542      0.459916      2.174308
JALYR41     1     -2.616491     0.061638      -42.450      0.0001       419.134      2187.322     -0.377727      0.406443      2.460367
JALYR42     1     -2.727771     0.063034      -43.274      0.0001      1063.753      2273.157     -0.374549      0.429592      2.327791
JALYR43     1     -2.604651     0.061965      -42.034      0.0001      3598.951      2144.741     -0.371279      0.412493      2.424283
PROPDUM     1     -0.114746     0.033435       -3.432      0.0006      2.784645     14.297247     -0.022054      0.779321      1.283167
NEEDDUM     1   -0.00973929     0.025531       -0.381      0.7029      1677.252      0.176637     -0.002522      0.736329      1.358088
OTEACHD     1      0.374356     0.039064        9.583      0.0001      2933.884       111.479      0.067344      0.651689      1.534474
MAJTEACH    1      0.853609     0.092414        9.237      0.0001       857.667       103.563      0.054870      0.911964      1.096535
RURAL50     1     -2.318966     0.044240      -52.418      0.0001      3539.561      3335.276     -0.566930      0.275116      3.634827
RURAL99     1     -1.912767     0.044469      -43.014      0.0001      1694.610      2245.861     -0.406364      0.360575      2.773350
RURAL169    1     -1.282257     0.050570      -25.356      0.0001       285.601       780.427     -0.198506      0.525085      1.904452
RURAL170    1     -0.671919     0.061992      -10.839      0.0001      0.018212       142.605     -0.073322      0.703258      1.421953
URBAN100    1     -1.324239     0.048114      -27.523      0.0001      1558.615       919.494     -0.231133      0.456319      2.191451
URBAN199    1     -0.396141     0.045584       -8.690      0.0001       272.538     91.672031     -0.071351      0.477391      2.094719
URBAN404    1      0.069905     0.055285        1.264      0.2061      1.366824      1.940698      0.008968      0.639800      1.562989
URBAN504    1      0.191003     0.070824        2.697      0.0070      2.773944      8.828545      0.017816      0.737420      1.356079
URBAN505    1      0.422468     0.075781        5.575      0.0001     44.680891     37.725239      0.036884      0.735179      1.360212
RNEWENG     1     -0.057164     0.094662       -0.604      0.5459       170.079      0.442641     -0.004410      0.603427      1.657201
RSOATL      1     -0.487544     0.067095       -7.266      0.0001       295.787     64.092812     -0.094595      0.189897      5.266008
RNECENT     1     -0.652052     0.064666      -10.083      0.0001       332.812       123.420     -0.144007      0.157783      6.337802
RSECENT     1     -0.534601     0.072158       -7.409      0.0001       311.196     66.628234     -0.082799      0.257661      3.881064
RNWCENT     1     -1.043380     0.066822      -15.614      0.0001     70.798319       295.947     -0.223694      0.156801      6.377500
RSWCENT     1     -0.972513     0.066746      -14.570      0.0001       381.843       257.692     -0.208919      0.156527      6.388687
RMOUNT      1     -1.801960     0.078392      -22.987      0.0001     33.135664       641.379     -0.212013      0.378295      2.643437
RPACIFIC    1     -1.896312     0.068640      -27.627      0.0001       926.475       926.475     -0.332322      0.222413      4.496148

TEST: J1X        NUMERATOR:     1286.73  DF:     1   F VALUE: 1060.0352
                 DENOMINATOR:   1.21386  DF:11579   PROB >F :    0.0001
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DEP VARIABLE: HOCC     TOTAL OCCUPANCY

                    SUM OF         MEAN
SOURCE     DF      SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36      179.757     4.993252      307.936       0.0001
ERROR   11579      187.756     0.016215
C TOTAL11615       367.513

    ROOT MSE      0.127339     R-SQUARE       0.4891
    DEP MEAN      0.493279     ADJ R-SQ       0.4875
    C.V.          25.81479

                 PARAMETER    STANDARD   T FOR H0:                                    STANDARDIZED                 VARIANCE
VARIABLE  DF      ESTIMATE       ERROR PARAMETER=0  PROB > |T|   TYPE I SS  TYPE II SS    ESTIMATE   TOLERANCE   INFLATION

INTERCEP   1      0.756469 0.009471376      79.869      0.0001    2826.459     103.438    0.000000           .    0.000000
JALYR11    1     -0.078886 0.007115125     -11.087      0.0001    0.387134    1.993211   -0.109061    0.455979    2.193083
JALYR12    1     -0.105618 0.007239324     -14.589      0.0001    0.021993    3.451436   -0.140925    0.472881    2.114697
JALYR13    1     -0.110172 0.007160365     -15.386      0.0001    0.047388    3.838773   -0.150218    0.462886    2.160361
JALYR20    1   0.009063859 0.007431057       1.220      0.2226    6.158824    0.024124    0.011489    0.497299    2.010865
JALYR21    1     -0.057927 0.007068774      -8.195      0.0001    0.964313    1.088922   -0.081653    0.444407    2.250189
JALYR22    1     -0.090045 0.007244517     -12.429      0.0001    0.021693    2.505081   -0.120549    0.469050    2.131969
JALYR23    1     -0.101907 0.007096232     -14.361      0.0001    0.031682    3.344069   -0.142534    0.447882    2.232730
JALYR30    1      0.021025 0.007473583       2.813      0.0049    5.866154    0.128329    0.026610    0.493146    2.027795
JALYR31    1     -0.052541 0.007114274      -7.385      0.0001    0.997149    0.884429   -0.073841    0.441357    2.265741
JALYR32    1     -0.086328 0.007244542     -11.916      0.0001    0.034232    2.302541   -0.116647    0.460453    2.171773
JALYR33    1     -0.098283 0.007112065     -13.819      0.0001    0.018454    3.096627   -0.138127    0.441631    2.264334
JALYR40    1      0.013354  0.00745718       1.791      0.0734    3.426339    0.051998    0.017540    0.459916    2.174308
JALYR41    1     -0.070207 0.007124007      -9.855      0.0001 0.001576192    1.574849   -0.102679    0.406443    2.460367
JALYR42    1     -0.106726 0.007285421     -14.649      0.0001    1.935883    3.479788   -0.148461    0.429592    2.327791
JALYR43    1     -0.126493 0.007161825     -17.662      0.0001   12.798261    5.058319   -0.182666    0.412493    2.424283
PROPDUM    1     -0.042142 0.003864322     -10.905      0.0001    0.445077    1.928423   -0.082055    0.779321    1.283167
NEEDDUM    1     -0.018659 0.002950856      -6.323      0.0001   19.280003    0.648309   -0.048946    0.736329    1.358088
OTEACHD    1      0.027488 0.004514922       6.088      0.0001   23.014940    0.601058    0.050096    0.651689    1.534474
MAJTEACH   1      0.123457    0.010681      11.558      0.0001   11.336190    2.166315    0.080396    0.911964    1.096535
RURAL50    1     -0.234718 0.005113168     -45.905      0.0001   41.696531   34.169184   -0.581330    0.275116    3.634827
RURAL99    1     -0.171837 0.005139633     -33.434      0.0001   13.947021   18.125613   -0.369839    0.360575    2.773350
RURAL169   1     -0.085952 0.005844813     -14.706      0.0001    0.243985    3.506682   -0.134802    0.525085    1.904452
RURAL170   1     -0.034492 0.007164916      -4.814      0.0001    0.562096    0.375785   -0.038131    0.703258    1.421953
URBAN100   1     -0.157154 0.005561008     -28.260      0.0001   15.416072   12.949913   -0.277884    0.456319    2.191451
URBAN199   1     -0.072183 0.005268566     -13.701      0.0001    5.592062    3.043708   -0.131713    0.477391    2.094719
URBAN404   1      0.012977 0.006389829       2.031      0.0423    0.013637    0.066876    0.016865    0.639800    1.562989
URBAN504   1      0.021771 0.008185739       2.660      0.0078 0.002240019    0.114705    0.020573    0.737420    1.356079
URBAN505   1      0.063666 0.008758703       7.269      0.0001    0.787418    0.856766    0.056312    0.735179    1.360212
RNEWENG    1      0.030541    0.010941       2.791      0.0053    2.080147    0.126349    0.023869    0.603427    1.657201
RSOATL     1     -0.023726 0.007754803      -3.060      0.0022    2.521021    0.151788   -0.046636    0.189897    5.266008
RNECENT    1     -0.073476  0.00747396      -9.831      0.0001    0.011513    1.567178   -0.164396    0.157783    6.337802
RSECENT    1   0.004704548 0.008339918       0.564      0.5727    6.257777  0.00515983    0.007382    0.257661    3.881064
RNWCENT    1     -0.108340   0.0077232     -14.028      0.0001    1.611703    3.190831   -0.235310    0.156801    6.377500
RSWCENT    1     -0.078168 0.007714473     -10.133      0.0001    0.126075    1.664821   -0.170119    0.156527    6.388687
RMOUNT     1     -0.102903 0.009060444     -11.357      0.0001    0.945724    2.091625   -0.122656    0.378295    2.643437
RPACIFIC   1     -0.066948 0.007933311      -8.439      0.0001    1.164769    1.164769   -0.118859    0.222413    4.496148

TEST: J1X          NUMERATOR:     4.28529  DF:      1   F VALUE:   264.2758
                   DENOMINATOR:  .0162152  DF:11579   PROB >F  :     0.0001
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Regressions for Table 2

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DEP VARIABLE: FTERN     FT EQUIV RNS

                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE        PROB>F

MODEL       36    194166587       5393516      1568.172        0.0001
ERROR    12234     42077185      3439.365
C TOTAL12270      236243772

     ROOT MSE     58.646095      R-SQUARE        0.8219
     DEP MEAN     99.700880      ADJ R-SQ        0.8214
     C.V.          58.82204

                  PARAMETER      STANDARD     T FOR H0:                                            STANDARDIZED                    VARIANCE
VARIABLE    DF     ESTIMATE         ERROR   PARAMETER=0     PROB > !T!    TYPE I SS    TYPE II SS       ESTIMATE     TOLERANCE    INFLATION

INTERCEP     1      202.915      4.107555        49.400         0.0001    121976998       8393453       0.000000             .     0.000000
JALYR11      1     0.516875      2.947487         0.175         0.8608      2031600       105.766       0.000918      0.531228     1.882430
JALYR12      1     0.183379      2.941814         0.062         0.9503      2265205     13.364322       0.000327      0.529572     1.888319
JALYR13      1    -0.990472      3.347101        -0.296         0.7673       986689       301.179      -0.001418      0.634016     1.577246
JALYR20      1    -4.224320      2.938729        -1.437         0.1506       833903      7106.780      -0.007598      0.521043     1.919226
JALYR21      1    -6.092925      2.935824        -2.075         0.0380       888766     14813.914      -0.010978      0.520306     1.921947
JALYR22      1    -3.448399      2.926729        -1.178         0.2387      1322477      4774.725      -0.006252      0.517128     1.933757
JALYR23      1     3.360081      3.245739         1.035         0.3006      1366949      3685.958       0.005080      0.604704     1.653701
JALYR30      1   -12.673196      2.947181        -4.300         0.0001       231353     63597.055      -0.022899      0.513406     1.947775
JALYR31      1   -12.297832      2.935538        -4.189         0.0001       250065     60361.474      -0.022394      0.509496     1.962726
JALYR32      1    -9.089983      2.935192        -3.097         0.0020       448181     32986.123      -0.016553      0.509616     1.962263
JALYR33      1    -9.652641      3.226638        -2.992         0.0028       276458     30780.091      -0.014859      0.590100     1.694627
JALYR40      1   -18.664104      2.980762        -6.262         0.0001       531206        134846      -0.034450      0.480939     2.079264
JALYR41      1   -18.422492      2.977470        -6.187         0.0001       920448        131668      -0.034023      0.481490     2.076887
JALYR42      1   -16.730985      2.970063        -5.633         0.0001      1919167        109141      -0.031095      0.477791     2.092966
JALYR43      1   -14.591289      3.218231        -4.534         0.0001      3287222     70701.924      -0.023208      0.555639     1.799728
PROPDUM      1   -11.983322      1.698725        -7.054         0.0001      2283366        171154      -0.030279      0.790224     1.265464
NEEDDUM      1    -2.739036      1.330286        -2.059         0.0395     11363112     14580.880      -0.009119      0.742287     1.347187
OTEACHD      1    31.996311      1.962412        16.305         0.0001     41383673        914319       0.076437      0.662421     1.509614
MAJTEACH     1      160.130      4.345253        36.852         0.0001     27426108       4670837       0.148269      0.899360     1.111902
RURAL50      1     -159.754      2.272252       -70.306         0.0001      8821182      17000758      -0.500289      0.287519     3.478029
RURAL99      1     -140.965      2.292127       -61.500         0.0001      9640099      13008420      -0.382923      0.375528     2.662918
RURAL169     1     -104.910      2.584407       -40.593         0.0001      3241305       5667455      -0.213132      0.528118     1.893517
RURAL170     1   -37.658254      3.198746       -11.773         0.0001       136985        476693      -0.053245      0.711746     1.404995
URBAN100     1     -140.623      2.443832       -57.542         0.0001     16233906      11388052      -0.323108      0.461737     2.165734
URBAN199     1   -84.304358      2.319045       -36.353         0.0001     21708240       4545271      -0.199876      0.481589     2.076461
URBAN404     1    81.138752      2.822940        28.743         0.0001       182072       2841394       0.136622      0.644358     1.551932
URBAN504     1      175.248      3.600350        48.675         0.0001      1681657       8148839       0.215703      0.741348     1.348893
URBAN505     1      363.104      3.763440        96.482         0.0001     31268866      32016191       0.430750      0.730395     1.369122
RNEWENG      1    -7.851504      4.822189        -1.628         0.1035    17147.528      9117.916      -0.008301      0.560130     1.785301
RSOATL       1   -16.623082      3.552854        -4.679         0.0001     8114.175     75291.594      -0.042792      0.174049     5.745514
RNECENT      1   -22.507171      3.440953        -6.541         0.0001    97207.743        147151      -0.064188      0.151179     6.614671
RSECENT      1   -26.390159      3.800342        -6.944         0.0001    72543.039        165851      -0.053840      0.242185     4.129072
RNWCENT      1   -18.496645      3.568339        -5.184         0.0001    20477.097     92412.771      -0.049366      0.160516     6.229891
RSWCENT      1   -29.979158      3.550479        -8.444         0.0001       934867        245213      -0.081788      0.155170     6.444549
RMOUNT       1     9.907236      4.031473        -2.457         0.0140    81392.283     20770.925      -0.016211      0.334558     2.989016
RPACIFIC     1     4.124935      3.576583         1.153         0.2488     4574.840      4574.840       0.009868      0.198872     5.028350

TEST: J1X         NUMERATOR:     5.28937   DF:     1     F VALUE:       0.0015
                  DENOMINATOR:   3439.36   DF:12234      PROB >F :      0.9687
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DEP VARIABLE: FTE       TOTAL FT EQUIV STAFF

                      SUM OF          MEAN
SOURCE      DF       SQUARES        SQUARE       F VALUE        PROB>F

MODEL       36    3637169516     101032487      1675.195        0.0001
ERROR    12234     737843454     60310.892
C TOTAL12270      4375012969

    ROOT MSE         245.583      R-SQUARE        0.8314
    DEP MEAN         437.558      ADJ R-SQ        0.8309
    C.V.            56.12581

                   PARAMETER      STANDARD    T FOR H0:                                             STANDARDIZED                    VARIANCE
VARIABLE   DF       ESTIMATE         ERROR  PARAMETER=0     PROB > !T!     TYPE I SS    TYPE II SS      ESTIMATE     TOLERANCE      INFLATION

INTERCEP    1        812.398     17.200541       47.231         0.0001    2349365197     134539256      0.000000             .       0.000000
JALYR11     1     -16.288745     12.342715       -1.320         0.1870      31093766        105039     -0.006723      0.531228       1.882430
JALYR12     1     -14.895343     12.318956       -1.209         0.2266      35114922     88175.700     -0.006169      0.529572       1.888319
JALYR13     1     -28.240749     14.016111       -2.015         0.0439      12212603        244846     -0.009395      0.634016       1.577246
JALYR20     1     -12.535900     12.306038       -1.019         0.3084      17493176     62585.003     -0.005240      0.521043       1.919226
JALYR21     1     -32.114505     12.293876       -2.612         0.0090      15893277        411548     -0.013446      0.520306       1.921947
JALYR22     1     -31.634771     12.255788       -2.581         0.0099      20794103        401830     -0.013327      0.517128       1.933757
JALYR23     1     -22.571206     13.591656       -1.661         0.0968      17391252        166326     -0.007929      0.604704       1.653701
JALYR30     1     -46.115391     12.341432       -3.737         0.0002       5826925        842086     -0.019362      0.513406       1.947775
JALYR31     1     -58.032497     12.292679       -4.721         0.0001       4563306       1344142     -0.024556      0.509496       1.962726
JALYR32     1     -56.048246     12.291229       -4.560         0.0001       6209759       1254091     -0.023717      0.509616       1.962263
JALYR33     1     -63.379610     13.511671       -4.691         0.0001       2846829       1327018     -0.022672      0.590100       1.694627
JALYR40     1     -73.198740     12.482056       -5.864         0.0001       6902202       2074105     -0.031396      0.480939       2.079264
JALYR41     1     -79.754714     12.468269       -6.397         0.0001      14126359       2467722     -0.034227      0.481490       2.076887
JALYR42     1     -82.426758     12.437253       -6.627         0.0001      33126685       2649008     -0.035599      0.477791       2.092966
JALYR43     1     -76.898168     13.476463       -5.706         0.0001      58816049       1963703     -0.028422      0.555639       1.799728
PROPDUM     1     -78.651151      7.113474      -11.057         0.0001      62794698       7372969     -0.046180      0.790224       1.265464
NEEDDUM     1      -6.363811      5.570623       -1.142         0.2533     175495845     78708.680     -0.004923      0.742287       1.347187
OTEACHD     1        139.130      8.217676       16.931         0.0001     722409478      17287904      0.077235      0.662421       1.509614
MAJTEACH    1        974.722     18.195913       53.568         0.0001     689209768     173065119      0.209724      0.899360       1.111902
RURAL50     1       -638.581      9.515142      -67.112         0.0001     154712084     271642244     -0.464703      0.287519       3.478029
RURAL99     1       -555.337      9.598370      -57.857         0.0001     152861036     201889654     -0.350547      0.375528       2.662918
RURAL169    1       -397.943     10.822301      -36.771         0.0001      44788540      81545271     -0.187864      0.528118       1.893517
RURAL170    1       -101.070     13.394869       -7.545         0.0001        325717       3433720     -0.033207      0.711746       1.404995
URBAN100    1       -554.847     10.233638      -54.218         0.0001     265526542     177288865     -0.296247      0.461737       2.165734
URBAN199    1       -345.044      9.711091      -35.531         0.0001     389608026      76139140     -0.190097      0.481589       2.076461
URBAN404    1        317.265     11.821171       26.839         0.0001       8784988      43442808      0.124138      0.644358       1.551932
URBAN504    1        768.067     15.076603       50.944         0.0001      31203737     156526061      0.219681      0.741348       1.348893
URBAN505    1       1640.484     15.759550      104.095         0.0001     651144650     653509593      0.452228      0.730395       1.369122
RNEWENG     1       5.739777     20.193099        0.284         0.7762        412832      4872.815      0.001410      0.560130       1.785301
RSOATL      1     -31.759585     14.877713       -2.135         0.0328        120998        274836     -0.018998      0.174049       5.745514
RNECENT     1     -47.380835     14.409121       -3.288         0.0010        355291        652118     -0.031400      0.151179       6.614671
RSECENT     1     -58.304815     15.914076       -3.664         0.0002        374795        809546     -0.027641      0.242185       4.129072
RNWCENT     1     -45.086839     14.942554       -3.017         0.0026        285147        549093     -0.027962      0.160516       6.229891
RSWCENT     1     -60.371047     14.867767       -4.061         0.0001       3610887        994401     -0.038273      0.155170       6.444549
RMOUNT      1     -30.139055     16.881945       -1.785         0.0742        701644        192225     -0.011460      0.334558       2.989016
RPACIFIC    1      10.841114     14.977077        0.724         0.4692     31600.174     31600.174      0.006027      0.198872       5.028350

TEST: J1X       NUMERATOR:      221764  DF:     1   F VALUE:     3.6770
                DENOMINATOR:   60310.9  DF:12234    PROB >F :    0.0552
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DEP VARIABLE: HIPDPFTE TOTAL PATIENT DAYS PER FTE

                   SUM OF         MEAN
SOURCE     DF     SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36   26738.756      742.743       54.154       0.0001
ERROR   10976      150539    13.715271
C TOTAL11012       177278

    ROOT MSE     3.703413     R-SQUARE       0.1508
    DEP MEAN     7.742943     ADJ R-SQ       0.1480
    C.V.         47.82953

                PARAMETER     STANDARD    T FOR H0:                                          STANDARDIZED                 VARIANCE
VARIABLE  DF     ESTIMATE        ERROR  PARAMETER=0    PROB > |T|    TYPE I SS    TYPE II SS      ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1     7.337794     0.269680       27.209        0.0001       660264     10154.056      0.000000            .     0.000000
JALYR11    1    -0.570090     0.192107       -2.968        0.0030      711.205       120.783     -0.035751     0.533045     1.876015
JALYR12    1    -1.009345     0.192744       -5.237        0.0001     1656.117       376.116     -0.062904     0.536179     1.865048
JALYR13    1    -1.265644     0.223907       -5.653        0.0001     1439.590       438.218     -0.061511     0.653318     1.530649
JALYR20    1     0.583472     0.193156        3.021        0.0025     6.999197       125.150      0.036454     0.531225     1.882442
JALYR21    1     0.086629     0.193347        0.448        0.6541      115.051      2.753297      0.005402     0.532171     1.879094
JALYR22    1    -0.372112     0.193012       -1.928        0.0539      624.006     50.978149     -0.023307     0.529372     1.889032
JALYR23    1    -0.618963     0.215264       -2.875        0.0040      778.711       113.395     -0.032178     0.617762     1.618747
JALYR30    1     1.223343     0.193459        6.324        0.0001      488.831       548.433      0.077003     0.521742     1.916656
JALYR31    1     0.715289     0.192227        3.721        0.0002      123.979       189.907      0.045572     0.515803     1.938723
JALYR32    1     0.190790     0.192905        0.989        0.3227    11.512809     13.416152      0.012068     0.519638     1.924416
JALYR33    1    -0.073054     0.214794       -0.340        0.7338      100.932      1.586534     -0.003837     0.607797     1.645287
JALYR40    1     1.241737     0.198132        6.267        0.0001     1416.336       538.707      0.077968     0.499878     2.000489
JALYR41    1     0.320293     0.197900        1.618        0.1056      348.759     35.925771      0.020136     0.499816     2.000737
JALYR42    1    -0.169426     0.197019       -0.860        0.3898      169.943     10.142585     -0.010756     0.494564     2.021984
JALYR43    1    -0.689354     0.214254       -3.217        0.0013     0.249895       141.981     -0.037426     0.571785     1.748908
PROPDUM    1     0.330737     0.116799        2.832        0.0046    10.352824       109.975      0.027626     0.812815     1.230292
NEEDDUM    1    -0.398084     0.088878       -4.479        0.0001      146.373       275.146     -0.045701     0.743119     1.345679
OTEACHD    1    -0.257065     0.127211       -2.021        0.0433      982.165     56.006353     -0.021872     0.660426     1.514173
MAJTEACH   1    -1.343864     0.278661       -4.823        0.0001     1116.902       318.979     -0.044836     0.895065     1.117237
RURAL50    1     2.216844     0.150680       14.712        0.0001     8674.601      2968.685      0.230699     0.314644     3.178197
RURAL99    1     0.373467     0.149384        2.500        0.0124      366.231     85.723119      0.035752     0.378296     2.643434
RURAL169   1     0.291913     0.167563        1.742        0.0815      224.620     41.625041      0.021102     0.527320     1.896383
RURAL170   1     0.288654     0.206906        1.395        0.1630      166.800     26.693817      0.014557     0.710588     1.407285
URBAN100   1     0.291421     0.163342        1.784        0.0744    48.674786     43.656649      0.022499     0.486468     2.055635
URBAN199   1     0.022776     0.151688        0.150        0.8806     0.525370      0.309220      0.001888     0.489568     2.042617
URBAN404   1    -0.279891     0.181784       -1.540        0.1237     2.768416     32.513860     -0.016883     0.643455     1.554110
URBAN504   1    -0.337577     0.230882       -1.462        0.1437    18.932995     29.320387     -0.014962     0.738847     1.353459
URBAN505   1    -0.242828     0.240475       -1.010        0.3126     0.850797     13.984965     -0.010424     0.725992     1.377425
RNEWENG    1    -1.582931     0.311802       -5.077        0.0001      570.333       353.486     -0.060682     0.541496     1.846735
RSOATL     1    -0.121028     0.234170       -0.517        0.6053     3.249462      3.663644     -0.010909     0.173650     5.758694
RNECENT    1    -0.072652     0.226459       -0.321        0.7484     0.143684      1.411625     -0.007333     0.148066     6.753735
RSECENT    1     0.712434     0.250110        2.848        0.0044      634.264       111.284      0.051409     0.237520     4.210167
RNWCENT    1     1.301626     0.235309        5.532        0.0001     5363.726       419.661      0.120522     0.162972     6.136041
RSWCENT    1    -0.792903     0.234852       -3.376        0.0007    17.286247       156.335     -0.074010     0.160997     6.211299
RMOUNT     1    -0.694621     0.282264       -2.461        0.0139    31.133444     83.059272     -0.033722     0.412007     2.427142
RPACIFIC   1    -1.225826     0.237102       -5.170        0.0001      366.600       366.600     -0.099300     0.209720     4.768257

TEST: J1X          NUMERATOR:      471.342   DF:      1    F VALUE:     34.3662
                   DENOMINATOR:    13.7153   DF:10976     PROB >F :      0.0001
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DEP VARIABLE: HIPDPFRN INPAT DAYS PER FTE RN

                     SUM OF         MEAN
SOURCE      DF      SQUARES       SQUARE      F VALUE       PROB>F

MODEL       36      5490596       152517       34.754       0.0001
ERROR    10976     48168428     4388.523
C TOTAL11012       53659024

    ROOT MSE      66.245928     R-SQUARE       0.1023
    DEP MEAN      46.733640     ADJ R-SQ       0.0994
    C.V.           141.7521

                  PARAMETER     STANDARD   T FOR H0:                                               STANDARDIZED                      VARIANCE
VARIABLE   DF      ESTIMATE        ERROR  PARAMETER=0   PROB > |T|   TYPE I SS   TYPE II SS       ESTIMATE     TOLERANCE     INFLATION

INTERCEP    1     27.334130     4.823974        5.666       0.0001    24052756       140903       0.000000          .        0.000000
JALYR11     1     -5.001070     3.436370       -1.455       0.1456      152896     9294.892      -0.018027      0.533045      1.876015
JALYR12     1     -6.810040     3.447767       -1.975       0.0483      216041    17121.503      -0.024395      0.536179      1.865048
JALYR13     1     -7.919811     4.005210       -1.977       0.0480      164669    17159.214      -0.022124      0.653318      1.530649
JALYR20     1      4.158398     3.455130        1.204       0.2288   15209.863     6356.845       0.014933      0.531225      1.882442
JALYR21     1      0.189573     3.458552        0.055       0.9563   57199.656    13.185092       0.000680      0.532171      1.879094
JALYR22     1     -3.845924     3.452554       -1.114       0.2653      138727     5445.512      -0.013846      0.529372      1.889032
JALYR23     1     -4.244348     3.850593       -1.102       0.2704      116812     5331.938      -0.012683      0.617762      1.618747
JALYR30     1     12.652890     3.460556        3.656       0.0003   16553.209    58668.652       0.045778      0.521742      1.916656
JALYR31     1     13.312735     3.438513        3.872       0.0001   32365.992    65782.696       0.048752      0.515803      1.938723
JALYR32     1      3.755506     3.450650        1.088       0.2765    7951.562     5198.206       0.013654      0.519638      1.924416
JALYR33     1      1.344521     3.842196        0.350       0.7264   23194.545      537.396       0.004059      0.607797      1.645287
JALYR40     1     16.275786     3.544152        4.592       0.0001      227177    92550.276       0.058740      0.499878      2.000489
JALYR41     1      5.346951     3.540000        1.510       0.1310   67534.057    10012.078       0.019321      0.499816      2.000737
JALYR42     1      0.318596     3.524230        0.090       0.9280   59451.100    35.864891       0.001163      0.494564      2.021984
JALYR43     1     -3.060402     3.832535       -0.799       0.4246   35048.951     2798.357      -0.009550      0.571785      1.748908
PROPDUM     1     -3.241698     2.089271       -1.552       0.1208   77023.920    10565.108      -0.015564      0.812815      1.230292
NEEDDUM     1     -1.202246     1.589836       -0.756       0.4495      264605     2509.574      -0.007933      0.743119      1.345679
OTEACHD     1      0.568316     2.275531        0.250       0.8028      182246      273.736       0.002779      0.660426      1.514173
MAJTEACH    1      0.527803     4.984638        0.106       0.9157   61762.539    49.203393       0.001012      0.895065      1.117237
RURAL50     1     41.906337     2.695332       15.548       0.0001     2542420      1060849       0.250666      0.314644      3.178197
RURAL99     1     10.898125     2.672158        4.078       0.0001      147277    72995.788       0.059967      0.378296      2.643434
RURAL169    1      5.521304     2.997340        1.842       0.0655   30795.779    14891.198       0.022941      0.527320      1.896383
RURAL170    1      2.393169     3.701102        0.647       0.5179    6518.029     1834.860       0.006937      0.710588      1.407285
URBAN100    1     10.949983     2.921827        3.748       0.0002   85947.236    61636.253       0.048593      0.486468      2.055635
URBAN199    1      0.475166     2.713371        0.175       0.8610    8.288024      134.583       0.002263      0.489568      2.042617
URBAN404    1     -4.110271     3.251724       -1.264       0.2062    2251.382     7011.841      -0.014251      0.643455      1.554110
URBAN504    1     -2.347044     4.129975       -0.568       0.5698     156.651     1417.313      -0.005979      0.738847      1.353459
URBAN505    1     -3.231715     4.301567       -0.751       0.4525    3.270418     2477.028      -0.007974      0.725992      1.377425
RNEWENG     1    -10.165991     5.577444       -1.823       0.0684   56207.334    14579.661      -0.022400      0.541496      1.846735
RSOATL      1      4.169655     4.188781        0.995       0.3195    2920.141     4348.538       0.021603      0.173650      5.758694
RNECENT     1      3.748549     4.050850        0.925       0.3548    5461.628     3757.962       0.021748      0.148066      6.753735
RSECENT     1     14.291005     4.473918        3.194       0.0014   63169.164    44778.320       0.059274      0.237520      4.210167
RNWCENT     1     20.142934     4.209167        4.785       0.0001      556721       100501       0.107203      0.162972      6.136041
RSWCENT     1      2.028019     4.200986        0.483       0.6293   53374.687     1022.727       0.010881      0.160997      6.211299
RMOUNT      1     -2.625967     5.049091       -0.520       0.6030    5114.349     1187.054      -0.007328      0.412007      2.427142
RPACIFIC    1     -8.043017     4.241230       -1.896       0.0579   15782.388    15782.388      -0.037449      0.209720      4.768257

TEST: J1X        NUMERATOR:     22669.5  DF:      1   F VALUE:      5.1656
                 DENOMINATOR:   4388.52  DF:10976    PROB >F :     0.0231
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DEP VARIABLE: RN_NRN   FTE RNS PER NON RNS

                  SUM OF        MEAN
SOURCE      DF   SQUARES      SQUARE      F VALUE     PROB>F

MODEL       36   38.565794    1.071272      122.476     0.0001
ERROR    10976   96.004641 0.008746779
C TOTAL11012       134.570

    ROOT MSE    0.093524    R-SQUARE       0.2866
    DEP MEAN    0.275104    ADJ R-SQ       0.2842
    C.V.        33.99595

               PARAMETER    STANDARD  T FOR H0:                                       STANDARDIZED                VARIANCE
VARIABLE  DF    ESTIMATE       ERROR  PARAMETER=0 PROB > |T|   TYPE I SS   TYPE II SS     ESTIMATE   TOLERANCE   INFLATION

INTERCEP  1     0.342466 0.006810356       50.286     0.0001     833.488    22.117878     0.000000           .    0.000000
JALYR11   1     0.014755 0.004851375        3.041     0.0024    0.810473     0.080911     0.033585    0.533045    1.876015
JALYR12   1     0.021872 0.004867465        4.493     0.0001    1.302200     0.176608     0.049474    0.536179    1.865048
JALYR13   1     0.023983 0.005654448        4.241     0.0001    0.992995     0.157352     0.042306    0.653318    1.530649
JALYR20   1  -0.00190557  0.00487786       -0.391     0.6961    0.063814  0.001334869    -0.004321    0.531225    1.882442
JALYR21   1  0.006469873  0.00488269        1.325     0.1852    0.257984     0.015358     0.014644    0.532171    1.879094
JALYR22   1     0.019457 0.004874223        3.992     0.0001    0.752723     0.139372     0.044232    0.529372    1.889032
JALYR23   1     0.035074 0.005436163        6.452     0.0001    1.251419     0.364118     0.066181    0.617762    1.618747
JALYR30   1    -0.012216 0.004885519       -2.500     0.0124 0.001497225     0.054688    -0.027909    0.521742    1.916656
JALYR31   1 -0.000160619   0.0048544       -0.033     0.9736    0.089482 .00000957568    -0.000371    0.515803    1.938723
JALYR32   1     0.012367 0.004871534        2.539     0.0111    0.549243     0.056369     0.028392    0.519638    1.924416
JALYR33   1     0.023536 0.005424309        4.339     0.0001    0.961320     0.164675     0.044870    0.607797    1.645287
JALYR40   1    -0.030831 0.005003538       -6.162     0.0001    0.845592     0.332102    -0.070263    0.499878    2.000489
JALYR41   1    -0.019473 0.004997676       -3.896     0.0001    0.671896     0.132792    -0.044433    0.499816    2.000737
JALYR42   1  -0.00695854 0.004975414       -1.399     0.1620    0.679403     0.017109    -0.016033    0.494564    2.021984
JALYR43   1  0.003928875 0.005410669        0.726     0.4678    0.430453  0.004611929     0.007742    0.571785    1.748908
PROPDUM   1     0.037015 0.002949576       12.549     0.0001    3.208900     1.377468     0.112220    0.812815    1.230292
NEEDDUM   1    -0.015410 0.002244488       -6.866     0.0001    5.451499     0.412296    -0.064210    0.743119    1.345679
OTEACHD   1    -0.013109 0.003212533       -4.081     0.0001    0.720315     0.145640    -0.040481    0.660426    1.514173
MAJTEACH  1    -0.046742 0.007037177       -6.642     0.0001 0.002577841     0.385893    -0.056602    0.895065    1.117237
RURAL50   1    -0.098128 0.003805196      -25.788     0.0001    6.669159     5.816714    -0.370642    0.314644    3.178197
RURAL99   1    -0.062120  0.00377248      -16.467     0.0001    3.634286     2.371687    -0.215843    0.378296    2.643434
RURAL169  1    -0.038467 0.004231564       -9.090     0.0001    1.134553     0.722807    -0.100925    0.527320    1.896383
RURAL170  1    -0.031557 0.005225116       -6.039     0.0001    0.545007     0.319033    -0.057761    0.710588    1.407285
URBAN100  1    -0.032959 0.004124957       -7.990     0.0001    0.635504     0.558421    -0.092359    0.486468    2.055635
URBAN199  1  0.005102671 0.003830664        1.332     0.1829    0.064694     0.015520     0.015349    0.489568    2.042617
URBAN404  1     0.011344 0.004590696        2.471     0.0135    0.082217     0.053406     0.024835    0.643455    1.554110
URBAN504  1  -0.00299446 0.005830587       -0.514     0.6076    0.035105  0.002307063    -0.004817    0.738847    1.353459
URBAN505  1  0.004117653 0.006072837        0.678     0.4978    0.033857  0.004021282     0.006416    0.725992    1.377425
RNEWENG   1    -0.016720 0.007874085       -2.123     0.0337    0.011287     0.039439    -0.023264    0.541496    1.846735
RSOATL    1    -0.032738 0.005913608       -5.536     0.0001 0.004141517     0.268071    -0.107106    0.173650    5.758694
RNECENT   1    -0.030170 0.005718881       -5.275     0.0001    0.079647     0.243426    -0.110530    0.148066    6.753735
RSECENT   1    -0.058021 0.006316157       -9.186     0.0001    0.759971     0.738100    -0.151961    0.237520    4.210167
RNWCENT   1    -0.024366 0.005942388       -4.100     0.0001 0.005425086     0.147057    -0.081886    0.162972    6.136041
RSWCENT   1    -0.062551 0.005930838      -10.547     0.0001    5.663473     0.972931    -0.211913    0.160997    6.211299
RMOUNT    1  0.008948062 0.007128171        1.255     0.2094    0.032749     0.013783     0.015767    0.412007    2.427142
RPACIFIC  1     0.023166 0.005987654        3.869     0.0001    0.130933     0.130933     0.068113    0.209720    4.768257

TEST: J1X      NUMERATOR:   0.213912  DF:     1   F VALUE:    24.4561
               DENOMINATOR: .0087468  DF:10976   PROB >F :    0.0001
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DEP VARIABLE: PAYRATE  AVERAGE PAY

                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE       PROB>F

MODEL       36    532053480      14779263       203.135       0.0001
ERROR     9283    675391616     72755.749
C TOTAL   9319   1207445096

    ROOT MSE       269.733      R-SQUARE        0.4406
    DEP MEAN      1473.672      ADJ R-SQ        0.4385
    C.V.          18.30345

                   PARAMETER      STANDARD    T FOR H0:                                                  STANDARDIZED                   VARIANCE
VARIABLE   DF       ESTIMATE         ERROR  PARAMETER=0    PROB > |T|   TYPE I SS   TYPE II SS      ESTIMATE     TOLERANCE     INFLATION

INTERCEP    1       1671.279     21.446307       77.929        0.0001 20240324228   441835166      0.000000             .      0.000000
JALYR11     1      92.957861     16.353836        5.684        0.0001    15364110     2350717      0.067212      0.430956      2.320420
JALYR12     1        151.178     16.342069        9.251        0.0001    34306430     6226288      0.109529      0.429834      2.326481
JALYR13     1        195.656     18.382084       10.644        0.0001    30925814     8242596      0.111864      0.545522      1.833107
JALYR20     1     -35.692662     17.472259       -2.043        0.0411   65129.411      303618     -0.022428      0.499900      2.000401
JALYR21     1      37.732328     16.224775        2.326        0.0201     4540638      393493      0.027882      0.419205      2.385469
JALYR22     1        114.177     16.182010        7.056        0.0001    20880213     3622069      0.084963      0.415561      2.406388
JALYR23     1        158.499     17.696651        8.956        0.0001    23997661     5836295      0.097709      0.506291      1.975150
JALYR30     1       -102.591     17.422526       -5.888        0.0001     3094058     2522704     -0.065420      0.488174      2.048448
JALYR31     1      -9.721064     16.360726       -0.594        0.5524      376093   25685.606     -0.007118      0.419829      2.381920
JALYR32     1      65.210689     16.347943        3.989        0.0001     8868952     1157654      0.047876      0.418291      2.390679
JALYR33     1        112.463     17.843377        6.303        0.0001    14709198     2890244      0.068854      0.504907      1.980564
JALYR40     1       -141.261     18.030812       -7.834        0.0001     9791436     4465599     -0.087082      0.487699      2.050446
JALYR41     1     -74.324442     16.922716       -4.392        0.0001     6969026     1403429     -0.052746      0.417779      2.393610
JALYR42     1     -15.195626     16.952212       -0.896        0.3701     4919940   58459.056     -0.010730      0.420491      2.378171
JALYR43     1      55.347063     18.148463        3.050        0.0023     1753018      676670      0.033683      0.493956      2.024471
PROPDUM     1      -9.190763     10.010345       -0.918        0.3586      542606   61329.909     -0.007783      0.838520      1.192577
NEEDDUM     1     -35.119446      6.990483       -5.024        0.0001    49307201     1836319     -0.044955      0.752523      1.328863
OTEACHD     1      14.459554     10.012481        1.444        0.1487    29243178      151738      0.013927      0.647922      1.543396
MAJTEACH    1      62.667391     23.105910        2.712        0.0067    12808994      535186      0.022195      0.899780      1.111382
RURAL50     1       -368.107     11.821137      -31.140        0.0001    50080443    70550118     -0.433198      0.311356      3.211758
RURAL99     1       -284.506     11.824938      -24.060        0.0001    53139642    42116553     -0.299976      0.387626      2.579807
RURAL169    1       -208.975     13.378571      -15.620        0.0001    22823757    17751478     -0.164915      0.540563      1.849923
RURAL170    1       -160.423     16.099632       -9.964        0.0001    11989972     7223870     -0.092248      0.703052      1.422370
URBAN100    1       -151.377     12.890893      -11.743        0.0001     3832146    10032838     -0.131580      0.479929      2.083642
URBAN199    1     -59.148280     12.221733       -4.840        0.0001      879934     1704064     -0.052683      0.508478      1.966654
URBAN404    1      23.778351     14.264174        1.667        0.0955    7526.719      202180      0.016201      0.637965      1.567484
URBAN504    1       3.067230     17.841097        0.172        0.8635      271431    2150.389      0.001566      0.726557      1.376355
URBAN505    1      56.373565     18.746538        3.007        0.0026    9.823784      657925      0.027465      0.722354      1.384362
RNEWENG     1     -31.515799     23.561405       -1.338        0.1811    9523.919      130173     -0.013841      0.562794      1.776850
RSOATL      1       -168.188     17.544583       -9.586        0.0001    21152784     6686090     -0.169556      0.192610      5.191839
RNECENT     1     -24.897346     16.836086       -1.479        0.1392      326709      159108     -0.028791      0.158963      6.290760
RSECENT     1       -179.188     19.229778       -9.318        0.0001    16360204     6317406     -0.134512      0.289169      3.458181
RNWCENT     1     -81.944729     17.576596       -4.662        0.0001    14928774     1581393     -0.085724      0.178226      5.610859
RSWCENT     1     -91.453588     17.751678       -5.152        0.0001    42624186     1931034     -0.090912      0.193498      5.168004
RMOUNT      1      36.821243     20.615431        1.786        0.0741     7790222      232102      0.022159      0.391478      2.554425
RPACIFIC    1        244.222     18.014103       13.557        0.0001    13372523    13372523      0.214353      0.241038      4.148718

TEST: JIX        NUMERATOR:     7659469  DF:    1   F VALUE:  105.2765
                 DENOMINATOR:   72755.7  DF: 9283   PROB >F :   0.0001
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Regressions for Table 3

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DEP VARIABLE: MHOIRDIS MEDI HOSP ONLY INPATIENT REV/DISCHARGE

                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE        PROB>F

MODEL       36  17331314118     481425392      1239.377        0.0001
ERROR    11579   4497761774        388441
C TOTAL11615    21829075893

    ROOT MSE        623.251      R-SQUARE        0.7940
    DEP MEAN       2808.978      ADJ R-SQ        0.7933
    C.V.            22.1878

                  PARAMETER      STANDARD    T FOR H0:                                           STANDARDIZED                  VARIANCE
VARIABLE    DF     ESTIMATE         ERROR  PARAMETER=0    PROB > !T!    TYPE I SS    TYPE II SS      ESTIMATE     TOLERANCE    INFLATION

INTERCEP     1     4001.226     46.356880       86.314        0.0001  91654409047    2893898088      0.000000          .        0.000000
JALYR11      1      421.861     34.824401       12.114        0.0001    848045426      57002812      0.075676      0.455979     2.193083
JALYR12      1      628.515     35.432286       17.738        0.0001   1317102872     122224580      0.108814      0.472881     2.114697
JALYR13      1      664.479     35.045826       18.960        0.0001   1594509808     139641909      0.117558      0.462886     2.160361
JALYR20      1     -561.850     36.370708      -15.448        0.0001      3161848      92696284     -0.092407      0.497299     2.010865
JALYR21      1     -205.664     34.597542       -5.944        0.0001    193299963      13726297     -0.037616      0.444407     2.250189
JALYR22      1    54.050525     35.457703        1.524        0.1274    479134552        902618      0.009389      0.469050     2.131969
JALYR23      1      116.170     34.731931        3.345        0.0008    701313883       4345652      0.021083      0.447882     2.232730
JALYR30      1     -838.283     36.578845      -22.917        0.0001     36286598     204007593     -0.137663      0.493146     2.027795
JALYR31      1     -553.347     34.820239      -15.892        0.0001      7077026      98097315     -0.100906      0.441357     2.265741
JALYR32      1     -282.207     35.457823       -7.959        0.0001    129388392      24605721     -0.049477      0.460453     2.171773
JALYR33      1     -237.298     34.809424       -6.817        0.0001    223900692      18051712     -0.043272      0.441631     2.264334
JALYR40      1    -1123.448     36.498564      -30.781        0.0001    306566617     368027331     -0.191462      0.459916     2.174308
JALYR41      1     -841.993     34.867874      -24.148        0.0001    217033495     226512117     -0.159782      0.406443     2.460367
JALYR42      1     -574.165     35.657901      -16.102        0.0001    137869561     100713335     -0.103633      0.429592     2.327791
JALYR43      1     -527.860     35.052974      -15.059        0.0001    465561061      88087309     -0.098908      0.412493     2.424283
PROPDUM      1      371.374     18.913609       19.635        0.0001    407478927     149761445      0.093826      0.779321     1.283167
NEEDDUM      1   -82.702470     14.442723       -5.726        0.0001   1092443463      12736913     -0.028150      0.736329     1.358088
OTEACHD      1      551.548     22.097919       24.959        0.0001   2053188641     241985743      0.130424      0.651689     1.534474
MAJTEACH     1     2438.773     52.278036       46.650        0.0001   2031598409     845336757      0.206067      0.911964     1.096535
RURAL50      1    -1693.441     25.025987      -67.667        0.0001   1206531610    1778619426     -0.544209      0.275116     3.634827
RURAL99      1    -1509.277     25.155518      -59.998        0.0001   1520867479    1398289087     -0.421486      0.360575     2.773350
RURAL169     1    -1355.959     28.606964      -47.400        0.0001   1057995240     872719864     -0.275934      0.525085     1.904452
RURAL170     1    -1010.561     35.068102      -28.817        0.0001    389532770     322571617     -0.144957      0.703258     1.421953
URBAN100     1     -675.160     27.217903      -24.806        0.0001    207648788     239017533     -0.154904      0.456319     2.191451
URBAN199     1     -163.354     25.786569       -6.335        0.0001     12440630      15588188     -0.038676      0.477391     2.094719
URBAN404     1     8.450283     31.274501        0.270        0.7870      3587941     28358.752      0.001425      0.639800     1.562989
URBAN504     1      115.354     40.064436        2.879        0.0040    37333.625       3220145      0.014144      0.737420     1.356079
URBAN505     1      352.052     42.868762        8.212        0.0001     10344984      26197375      0.040403      0.735179     1.360212
RNEWENG      1     -110.402     53.549596       -2.062        0.0393       454717       1651068     -0.011196      0.603427     1.657201
RSOATL       1     -314.932     37.955257       -8.297        0.0001     61665421      26743298     -0.080321      0.189897     5.266008
RNECENT      1   -94.103732     36.580691       -2.572        0.0101      2607785       2570605     -0.027319      0.157783     6.337802
RSECENT      1     -430.853     40.819052      -10.555        0.0001    105776864      43277097     -0.087718      0.257661     3.881064
RNWCENT      1     -217.457     37.800577       -5.753        0.0001     83853656      12855038     -0.061284      0.156801     6.377500
RSWCENT      1     -201.107     37.757865       -5.326        0.0001    254516631      11019609     -0.056790      0.156527     6.388687
RMOUNT       1   -51.063058     44.345608       -1.151        0.2496     91000998        515036     -0.007897      0.378295     2.643437
RPACIFIC     1      548.423     38.828950       14.124        0.0001     77490038      77490038      0.126336      0.222413     4.496148

TEST: J1X        NUMERATOR:      1.5E+08   DF:     1    F VALUE:   373.6147
                 DENOMINATOR:     388441   DF:11579    PROB >F :     0.0001
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DEP VARIABLE: HOIRDIS  HOSP ONLY INPATIENT REVENUE/DISCHARGE

                   SUM OF          MEAN
SOURCE    DF      SQUARES        SQUARE      F VALUE       PROB>F

MODEL     36  17337427049     481595196      579.421       0.0001
ERROR 11579   9624072363        831166
C TOTAL11615  26961499412

    ROOT MSE      911.683      R-SQUARE       0.6430
    DEP MEAN     3011.931      ADJ R-SQ       0.6419
        C.V.     30.26906

                PARAMETER      STANDARD  T FOR H0:                                          STANDARDIZED                  VARIANCE
VARIABLE  DF     ESTIMATE         ERROR  PARAMETER=0   PROB > !T!   TYPE I SS    TYPE II SS     ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1     4948.187     67.810260       72.971       0.0001105377191156    4425773078     0.000000       .          0.000000
JALYR11    1    91.856285     50.940695        1.803       0.0714   597386580       2702563     0.014827     0.455979     2.193083
JALYR12    1      426.331     51.829902        8.226       0.0001  1250672002      56236729     0.066414     0.472881     2.114697
JALYR13    1      852.690     51.264593       16.633       0.0001  2454867135     229951147     0.135740     0.462886     2.160361
JALYR20    1     -642.843     53.202615      -12.083       0.0001    16274384     121347678    -0.095134     0.497299     2.010865
JALYR21    1     -586.168     50.608850      -11.582       0.0001    61270459     111501054    -0.096467     0.444407     2.250189
JALYR22    1     -340.042     51.867082       -6.556       0.0001   236789341      35724797    -0.053150     0.469050     2.131969
JALYR23    1    33.861303     50.805431        0.666       0.5051   771583397        369211     0.005529     0.447882     2.232730
JALYR30    1     -925.235     53.507074      -17.292       0.0001    13034328     248524712    -0.136718     0.493146     2.027795
JALYR31    1     -879.525     50.934607      -17.268       0.0001     3000458     247832301    -0.144315     0.441357     2.265741
JALYR32    1     -618.795     51.867258      -11.930       0.0001    41926431     118302761    -0.097619     0.460453     2.171773
JALYR33    1     -308.222     50.918787       -6.053       0.0001   280945844      30455108    -0.050574     0.441631     2.264334
JALYR40    1    -1193.671     53.389639      -22.358       0.0001   211607086     415473148    -0.183046     0.459916     2.174308
JALYR41    1    -1114.210     51.004287      -21.845       0.0001   303318479     396651125    -0.190253     0.406443     2.460367
JALYR42    1     -888.500     52.159929      -17.034       0.0001   291092989     241172941    -0.144299     0.429592     2.327791
JALYR43    1     -614.970     51.275049      -11.994       0.0001   481048390     119559213    -0.103684     0.412493     2.424283
PROPDUM    1      661.473     27.666589       23.909       0.0001  1206556942     475117455     0.150373     0.779321     1.283167
NEEDDUM    1     -139.638     21.126634       -6.610       0.0001  1087771564      36310822    -0.042767     0.736329     1.358088
OTEACHD    1      419.667     32.324557       12.983       0.0001  1591227576     140098169     0.089294     0.651689     1.534474
MAJTEACH   1     1805.077     76.471653       23.605       0.0001  1320612525     463103896     0.137239     0.911964     1.096535
RURAL50    1    -1663.575     36.607699      -45.443       0.0001  1197383732    1716436324    -0.481043     0.275116     3.634827
RURAL99    1    -1488.755     36.797176      -40.458       0.0001  1282824629    1360521492    -0.374096     0.360575     2.773350
RURAL169   1    -1373.573     41.845907      -32.825       0.0001   884379315     895541007    -0.251510     0.525085     1.904452
RURAL170   1    -1021.218     51.297179      -19.908       0.0001   276341070     329410831    -0.131807     0.703258     1.421953
URBAN100   1     -885.424     39.814007      -22.239       0.0001   357586837     411072556    -0.182790     0.456319     2.191451
URBAN199   1     -289.792     37.720269       -7.683       0.0001    22657987      49058047    -0.061737     0.477391     2.094719
URBAN404   1   -33.813353     45.747946       -0.739       0.4598      296702        454068    -0.005131     0.639800     1.562989
URBAN504   1   -13.494853     58.605753       -0.230       0.8179     1152145     44070.057    -0.001489     0.737420     1.356079
URBAN505   1   -47.386914     62.707886       -0.756       0.4499    10284521        474636    -0.004893     0.735179     1.360212
RNEWENG    1     -930.122     78.331675      -11.874       0.0001    26905504     117190736    -0.084872     0.603427     1.657201
RSOATL     1     -534.897     55.520472       -9.634       0.0001    15481592      77147636    -0.122752     0.189897     5.266008
RNECENT    1     -800.489     53.509774      -14.960       0.0001   102420157     186008206    -0.209104     0.157783     6.337802
RSECENT    1     -730.840     59.709595      -12.240       0.0001     9894569     124521588    -0.133883     0.257661     3.881064
RNWCENT    1     -824.712     55.294208      -14.915       0.0001   147793836     184898313    -0.209132     0.156801     6.377500
RSWCENT    1     -805.342     55.231729      -14.581       0.0001   462251593     176713926    -0.204630     0.156527     6.388687
RMOUNT     1     -781.239     64.868198      -12.043       0.0001   312733220     120556966    -0.108720     0.378295     2.643437
RPACIFIC   1      153.287     56.798499        2.699       0.0070     6053731       6053731     0.031773     0.222413     4.496148

TEST: J1X        NUMERATOR:    92745232  DF:    1   F VALUE:  111.5845
                 DENOMINATOR:    831166  DF:11579   PROB >F :   0.0001
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DEP VARIABLE: MHOICDIS MEDI HOSP ONLY INPATIENT COST/DISCHARGE

                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE       PROB>F

MODEL       36  13008939701     361359436       925.476       0.0001
ERROR    11579   4521114121        390458
C TOTAL 11615   17530053822

    ROOT MSE        624.866      R-SQUARE        0.7421
    DEP MEAN       2904.118      ADJ R-SQ        0.7413
    C.V.           21.51656

                  PARAMETER      STANDARD   T FOR H0:                                         STANDARDIZED                  VARIANCE
VARIABLE   DF      ESTIMATE         ERROR  PARAMETER=0    PROB > |T|   TYPE I SS   TYPE II SS      ESTIMATE     TOLERANCE    INFLATION

INTERCEP    1      4237.273     46.477066       91.169        0.0001 97968206856   3245413023      0.000000          .        0.000000
JALYR11     1    -71.428441     34.914688       -2.046        0.0408   406537724      1634182     -0.014298      0.455979     2.193083
JALYR12     1       318.610     35.524149        8.969        0.0001  1019395708     31408467      0.061554      0.472881     2.114697
JALYR13     1       633.527     35.136687       18.030        0.0001  1863414071    126935574      0.125073      0.462886     2.160361
JALYR20     1      -646.429     36.465004      -17.727        0.0001    25371864    122705483     -0.118640      0.497299     2.010865
JALYR21     1      -620.081     34.687241      -17.876        0.0001    62784872    124776028     -0.126556      0.444407     2.250189
JALYR22     1      -276.371     35.549632       -7.774        0.0001   323195199     23598784     -0.053573      0.469050     2.131969
JALYR23     1      7.346211     34.821978        0.211        0.8329   817403038    17377.782      0.001488      0.447882     2.232730
JALYR30     1      -990.417     36.673681      -27.006        0.0001    11718381    284774713     -0.181498      0.493146     2.027795
JALYR31     1      -944.361     34.910515      -27.051        0.0001     2393945    285717990     -0.192169      0.441357     2.265741
JALYR32     1      -647.214     35.549753      -18.206        0.0001    53356673    129418787     -0.126623      0.460453     2.171773
JALYR33     1      -387.941     34.899672      -11.116        0.0001   276377213     48246165     -0.078942      0.441631     2.264334
JALYR40     1     -1348.507     36.593191      -36.851        0.0001   245524720    530249816     -0.256454      0.459916     2.174308
JALYR41     1     -1254.609     34.958273      -35.889        0.0001   349701962    502911402     -0.265677      0.406443     2.460367
JALYR42     1      -966.584     35.750349      -27.037        0.0001   274537294    285425737     -0.194683      0.429592     2.327791
JALYR43     1      -711.206     35.143853      -20.237        0.0001   482915734    159906616     -0.148708      0.412493     2.424283
PROPDUM     1       214.722     18.962645       11.323        0.0001   188635570     50064506      0.060536      0.779321     1.283167
NEEDDUM     1    -37.687467     14.480168       -2.603        0.0093   635312064      2644972     -0.014315      0.736329     1.358088
OTEACHD     1       409.044     22.155210       18.463        0.0001  1268313813    133095032      0.107937      0.651689     1.534474
MAJTEACH    1      1823.144     52.413574       34.784        0.0001  1203267241    472420804      0.171903      0.911964     1.096535
RURAL50     1     -1359.735     25.090871      -54.192        0.0001   712167646   1146703951     -0.487614      0.275116     3.634827
RURAL99     1     -1286.285     25.220737      -51.001        0.0001  1112732680   1015624500     -0.400846      0.360575     2.773350
RURAL169    1     -1154.744     28.681132      -40.261        0.0001   762061751    632926336     -0.262223      0.525085     1.904452
RURAL170    1      -848.254     35.159021      -24.126        0.0001   266059233    227275776     -0.135777      0.703258     1.421953
URBAN100    1      -569.475     27.288470      -20.869        0.0001   142061720    170045309     -0.145800      0.456319     2.191451
URBAN199    1      -155.400     25.853424       -6.011        0.0001     9158912     14107201     -0.041057      0.477391     2.094719
URBAN404    1     10.660722     31.355584        0.340        0.7339      900933    45135.459      0.002006      0.639800     1.562989
URBAN504    1     75.969291     40.168309        1.891        0.0586    3783.796      1396637      0.010394      0.737420     1.356079
URBAN505    1       164.009     42.979906        3.816        0.0001      588845      5685630      0.021004      0.735179     1.360212
RNEWENG     1    -78.861542     53.688430       -1.469        0.1419    2125.417       842449     -0.008924      0.603427     1.657201
RSOATL      1      -237.753     38.053661       -6.248        0.0001    19930432     15241700     -0.067665      0.189897     5.266008
RNECENT     1      -123.091     36.675531       -3.356        0.0008     3563912      4398207     -0.039876      0.157783     6.337802
RSECENT     1      -383.750     40.924881       -9.377        0.0001    69720527     34331831     -0.087183      0.257661     3.881064
RNWCENT     1      -251.687     37.898580       -6.641        0.0001    91961289     17220732     -0.079152      0.156801     6.377500
RSWCENT     1      -182.118     37.855757       -4.811        0.0001   175290832      9036825     -0.057388      0.156527     6.388687
RMOUNT      1    -94.962626     44.460580       -2.136        0.0327    79587751      1781269     -0.016389      0.378295     2.643437
RPACIFIC    1       453.514     38.929619       11.650        0.0001    52990243     52990243      0.116581      0.222413     4.496148

TEST: J1X        NUMERATOR:    38278894  DF:     1   F VALUE:    98.0359
                 DENOMINATOR:    390458  DF:11579   PROB >F :    0.0001
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DEP VARIABLE: HOICDIS  HOSP ONLY INPATIENT COST/DISCHARGE

                  SUM OF          MEAN
SOURCE    DF     SQUARES        SQUARE       F VALUE       PROB>F

MODEL     36  5753252801     159812578       517.669       0.0001
ERROR  11579  3574622643        308716
C TOTAL11615  9327875443

    ROOT MSE     555.622      R-SQUARE        0.6168
    DEP MEAN    2143.374      ADJ R-SQ        0.6156
    C.V.        25.92279

                PARAMETER      STANDARD   T FOR H0:                                         STANDARDIZED                  VARIANCE
VARIABLE  DF     ESTIMATE         ERROR  PARAMETER=0   PROB > |T|   TYPE I SS   TYPE II SS      ESTIMATE    TOLERANCE    INFLATION

INTERCEP  1      3034.705     41.326733       73.432       0.0001 53364485964   1664677005      0.000000            .     0.000000
JALYR11   1     53.458748     31.045634        1.722       0.0851   268505649       915368      0.014670     0.455979     2.193083
JALYR12   1       239.113     31.587557        7.570       0.0001   502399174     17690301      0.063329     0.472881     2.114697
JALYR13   1       472.423     31.243032       15.121       0.0001   931784337     70585275      0.127858     0.462886     2.160361
JALYR20   1      -468.560     32.424153      -14.451       0.0001     8491887     64469177     -0.117890     0.497299     2.010865
JALYR21   1      -447.630     30.843392      -14.513       0.0001    23473397     65024045     -0.125243     0.444407     2.250189
JALYR22   1      -259.955     31.610217       -8.224       0.0001   108791714     20878563     -0.069080     0.469050     2.131969
JALYR23   1    -69.421299     30.963197       -2.242       0.0250   297177150      1551862     -0.019273     0.447882     2.232730
JALYR30   1      -693.330     32.609705      -21.261       0.0001     6832611    139555086     -0.174178     0.493146     2.027795
JALYR31   1      -648.993     31.041923      -20.907       0.0001     1343555    134940195     -0.181044     0.441357     2.265741
JALYR32   1      -489.069     31.610324      -15.472       0.0001    13652632     73899648     -0.131171     0.460453     2.171773
JALYR33   1      -310.261     31.032282       -9.998       0.0001    94112647     30859292     -0.086551     0.441631     2.264334
JALYR40   1      -933.778     32.538134      -28.698       0.0001   113219173    254250205     -0.243444     0.459916     2.174308
JALYR41   1      -850.338     31.084389      -27.356       0.0001   147225198    231024350     -0.246852     0.406443     2.460367
JALYR42   1      -665.644     31.788692      -20.940       0.0001   115788179    135362344     -0.183793     0.429592     2.327791
JALYR43   1      -498.484     31.249404      -15.952       0.0001   204487246     78555653     -0.142886     0.412493     2.424283
PROPDUM   1       202.685     16.861309       12.021       0.0001   146273249     44608690      0.078336     0.779321     1.283167
NEEDDUM   1    -53.414044     12.875555       -4.148       0.0001   273317350      5312979     -0.027813     0.736329     1.358088
OTEACHD   1       285.997     19.700092       14.518       0.0001   523860662     65064859      0.103457     0.651689     1.534474
MAJTEACH  1      1216.262     46.605389       26.097       0.0001   507843657    210252441      0.157214     0.911964     1.096535
RURAL50   1      -805.135     22.310438      -36.088       0.0001   180358209    402050633     -0.395814     0.275116     3.634827
RURAL99   1      -854.553     22.425914      -38.106       0.0001   479635035    448267165     -0.365073     0.360575     2.773350
RURAL169  1      -828.155     25.502846      -32.473       0.0001   401935980    325540284     -0.257808     0.525085     1.904452
RURAL170  1      -591.927     31.262891      -18.934       0.0001   130082983    110671834     -0.129888     0.703258     1.421953
URBAN100  1      -325.029     24.264511      -13.395       0.0001    35638226     55393676     -0.114079     0.456319     2.191451
URBAN199  1      -118.517     22.988490       -5.155       0.0001     3170756      8205354     -0.042926     0.477391     2.094719
URBAN404  1    -28.931875     27.880930       -1.038       0.2994      724874       332428     -0.007463     0.639800     1.562989
URBAN504  1    -11.291757     35.717077       -0.316       0.7519      619716    30855.340     -0.002118     0.737420     1.356079
URBAN505  1     62.147410     38.217108        1.626       0.1039   14203.296       816375      0.010911     0.735179     1.360212
RNEWENG   1      -151.630     47.738973       -3.176       0.0015     1768323      3114478     -0.023523     0.603427     1.657201
RSOATL    1      -109.354     33.836763       -3.232       0.0012      511125      3224407     -0.042665     0.189897     5.266008
RNECENT   1      -125.294     32.611350       -3.842       0.0001     8392204      4557017     -0.055644     0.157783     6.337802
RSECENT   1      -260.103     36.389810       -7.148       0.0001    31318968     15772134     -0.081008     0.257661     3.881064
RNWCENT   1      -142.886     33.698867       -4.240       0.0001    22843832      5550182     -0.061601     0.156801     6.377500
RSWCENT   1      -134.373     33.660790       -3.992       0.0001    73721181      4919644     -0.058047     0.156527     6.388687
RMOUNT    1      -169.707     39.533703       -4.293       0.0001    68111619      5688822     -0.040152     0.378295     2.643437
RPACIFIC  1       316.608     34.615652        9.146       0.0001    25826098     25826098      0.111573     0.222413     4.496148

TEST: J1X         NUMERATOR:    28880946  DF:     1   F VALUE:    93.5518
                  DENOMINATOR:    308716  DF:11579   PROB >F :    0.0001
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DEP VARIABLE: TEHD_B   TOT EXPENSE PER ADJ DISCH(B)

                   SUM OF          MEAN
SOURCE     DF     SQUARES        SQUARE       F VALUE        PROB>F

MODEL      36  9250566020     256960167       218.070        0.0001
ERROR    8681 10229172587       1178340
C TOTAL  8717 19479738607

    ROOT MSE     1085.514      R-SQUARE        0.4749
    DEP MEAN     3087.818      ADJ R-SQ        0.4727
    C.V.         35.15472

                PARAMETER      STANDARD   T FOR H0:                                          STANDARDIZED                    VARIANCE
VARIABLE  DF     ESTIMATE         ERROR PARAMETER=0   PROB > !T!    TYPE I SS    TYPE II SS      ESTIMATE     TOLERANCE     INFLATION

INTERCEP   1     4061.003     89.533630      45.357       0.0001 83122836763    2424180113      0.000000            .       0.000000
JALYR11    1      441.519     64.526072       6.842       0.0001   393457012      55169519      0.077202      0.475186      2.104439
JALYR12    1      889.713     65.053944      13.677       0.0001  1088301918     220406113      0.153094      0.482753      2.071454
JALYR13    1     1294.355     72.895052      17.756       0.0001  1224247243     371519466      0.180308      0.586636      1.704635
JALYR20    1     -530.308     67.038925      -7.910       0.0001    10366551      73734904     -0.086105      0.510541      1.958705
JALYR21    1     -175.504     64.822036      -2.707       0.0068    49246789       8637732     -0.030533      0.475627      2.102489
JALYR22    1      190.918     65.704865       2.906       0.0037   281291455       9948767      0.032358      0.487778      2.050111
JALYR23    1      579.095     70.627568       8.199       0.0001   531886649      79217679      0.085715      0.553511      1.806649
JALYR30    1     -754.602     67.783386     -11.133       0.0001    58447756     146035912     -0.121263      0.509820      1.961477
JALYR31    1     -440.795     65.286958      -6.752       0.0001    1025.771      53714536     -0.076465      0.471611      2.120392
JALYR32    1   -85.161362     65.958379      -1.291       0.1967   105968824       1964337     -0.014445      0.483291      2.069145
JALYR33    1      253.519     70.641234       3.589       0.0003   280079436      15176677      0.037839      0.544159      1.837699
JALYR40    1    -1139.961     70.000459     -16.285       0.0001   261496213     312499500     -0.178150      0.505467      1.978369
JALYR41    1     -869.361     67.955127     -12.793       0.0001   205331430     192852956     -0.144470      0.474340      2.108193
JALYR42    1     -533.169     68.552311      -7.778       0.0001   140316308      71278012     -0.087448      0.478489      2.089914
JALYR43    1     -230.994     72.256236      -3.197       0.0014    70726538      12042630     -0.033974      0.535597      1.867074
PROPDUM    1      258.056     38.595603       6.686       0.0001    79884741      52677059      0.057898      0.806710      1.239603
NEEDDUM    1     -119.846     29.433356      -4.072       0.0001   404004568      19535964     -0.036506      0.752535      1.328842
OTEACHD    1      506.401     41.708775      12.141       0.0001   725668835     173702128      0.116554      0.656399      1.523463
MAJTEACH   1     2170.816     96.531021      22.488       0.0001  1058982682     595913212      0.183827      0.905275      1.104636
RURAL50    1     -632.464     50.087354     -12.627       0.0001   44236.985     187882205     -0.168489      0.339749      2.943348
RURAL99    1    -1008.941     48.259288     -20.907       0.0001   590350097     515039267     -0.263533      0.380703      2.626718
RURAL169   1    -1046.172     54.020647     -19.366       0.0001   666962771     441933708     -0.207063      0.529141      1.889857
RURAL170   1     -807.708     67.332664     -11.996       0.0001   265921228     169561619     -0.110326      0.715139      1.398329
URBAN100   1   -76.802581     53.965965      -1.423       0.1547     7802225       2386616     -0.015641      0.500821      1.996720
URBAN199   1     -111.214     49.147233      -2.263       0.0237   42875.894       6033771     -0.025241      0.486157      2.056947
URBAN404   1     -103.116     58.335797      -1.768       0.0772     5124468       3681720     -0.017287      0.632463      1.581120
URBAN504   1    36.636737     73.142709       0.501       0.6165      759084        295639      0.004574      0.725439      1.378477
URBAN505   1    63.352186     77.744287       0.815       0.4152     2370275        782451      0.007447      0.724375      1.380501
RNEWENG    1     -594.275       104.414      -5.692       0.0001     4244508      38170572     -0.058937      0.564123      1.772663
RSOATL     1     -627.515     76.356011      -8.218       0.0001    11889198      79585240     -0.152917      0.174718      5.723493
RNECENT    1     -536.755     73.574974      -7.295       0.0001    15899915      62713634     -0.149385      0.144266      6.931634
RSECENT    1     -854.474     83.203943     -10.270       0.0001    82010156     124274137     -0.154933      0.265771      3.762635
RNWCENT    1     -410.640     76.580824      -5.362       0.0001      120466      33880752     -0.103931      0.161021      6.210359
RSWCENT    1     -859.906     76.461670     -11.246       0.0001   556381618     149034037     -0.216143      0.163765      6.106321
RMOUNT     1     -388.573     95.788822      -4.057       0.0001    64660026      19390331     -0.046925      0.452056      2.212115
RPACIFIC   1      180.926     78.390727       2.308       0.0210     6276899       6276899      0.038096      0.222031      4.503867

TEST: J1X       NUMERATOR:     2.9E+08  DF:    1   F VALUE:  249.0435
                DENOMINATOR:   1178340  DF: 8681   PROB >F :   0.0001
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DEP VARIABLE: TRHD_B    TOT PAT REVENUE PER ADJ DISCH(B)

                   SUM OF         MEAN
SOURCE    DF      SQUARES       SQUARE      F VALUE     PROB>F

MODEL     36  17215927097    478220197      283.749     0.0001
ERROR   8681  14630661905      1685366
C TOTAL 8717  31846589002

    ROOT MSE     1298.216     R-SQUARE       0.5406
    DEP MEAN     3771.208     ADJ R-SQ       0.5387
    C.V.         34.42442

                PARAMETER     STANDARD   T FOR H0:                                       STANDARDIZED                  VARIANCE
VARIABLE  DF     ESTIMATE        ERROR  PARAMETER=0 PROB > !T!   TYPE I SS   TYPE II SS      ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1     5682.156      107.077       53.066     0.0001123987481274   4745965981      0.000000       .          0.000000
JALYR11    1      451.775    77.169727        5.854     0.0001   637990400     57762215      0.061782     0.475186     2.104439
JALYR12    1     1038.224    77.801033       13.345     0.0001  1815696662    300127374      0.139720     0.482753     2.071454
JALYR13    1     1660.319    87.178579       19.045     0.0001  2250815680    611304732      0.180889     0.586636     1.704635
JALYR20    1     -648.817    80.174965       -8.093     0.0001     2264302    110372700     -0.082392     0.510541     1.958705
JALYR21    1     -288.781    77.523684       -3.725     0.0002    82934619     23386401     -0.039293     0.475627     2.102489
JALYR22    1      108.068    78.579500        1.375     0.1691   396224760      3187624      0.014325     0.487778     2.050111
JALYR23    1      679.177    84.466789        8.041     0.0001   862771233    108965226      0.078623     0.553511     1.806649
JALYR30    1     -978.964    81.065300      -12.076     0.0001    85737204    245786277     -0.123038     0.509820     1.961477
JALYR31    1     -660.615    78.079706       -8.461     0.0001     2740431    120646606     -0.089626     0.471611     2.120392
JALYR32    1     -232.738    78.882689       -2.950     0.0032   122492247     14671133     -0.030874     0.483291     2.069145
JALYR33    1      246.078    84.483133        2.913     0.0036   421137863     14298779      0.028725     0.544159     1.837699
JALYR40    1    -1321.961    83.716800      -15.791     0.0001   364846269    420248341     -0.161575     0.505467     1.978369
JALYR41    1    -1057.103    81.270693      -13.007     0.0001   328141023    285142042     -0.137390     0.474340     2.108193
JALYR42    1     -676.897    81.984893       -8.256     0.0001   273327168    114887306     -0.086830     0.478489     2.089914
JALYR43    1     -320.083    86.414589       -3.704     0.0002   170419645     23123033     -0.036819     0.535597     1.867074
PROPDUM    1      676.578    46.158275       14.658     0.0001   659266115    362101610      0.118720     0.806710     1.239603
NEEDDUM    1     -213.212    35.200718       -6.057     0.0001  1040560627     61831971     -0.050794     0.752535     1.328842
OTEACHD    1      637.524    49.881462       12.781     0.0001  1494023741    275301993      0.114760     0.656399     1.523463
MAJTEACH   1     2726.255      115.446       23.615     0.0001  1867612671    939874256      0.180556     0.905275     1.104636
RURAL50    1    -1316.454    59.901793      -21.977     0.0001   202471886    814003128     -0.274285     0.339749     2.943348
RURAL99    1    -1489.926    57.715525      -25.815     0.0001  1115360584   1123151039     -0.304365     0.380703     2.626718
RURAL169   1    -1453.886    64.605801      -22.504     0.0001  1014047666    853516258     -0.225055     0.529141     1.889857
RURAL170   1    -1119.150    80.526261      -13.898     0.0001   362158924    325533291     -0.119556     0.715139     1.398329
URBAN100   1     -592.150    64.540404       -9.175     0.0001    61539099    141871126     -0.094314     0.500821     1.996720
URBAN199   1     -254.844    58.777458       -4.336     0.0001     1065289     31682561     -0.045237     0.486157     2.056947
URBAN404   1     -192.288    69.766489       -2.756     0.0059    12060216     12802844     -0.025212     0.632463     1.581120
URBAN504   1   -30.037544    87.474763       -0.343     0.7313     3859926       198727     -0.002933     0.725439     1.378477
URBAN505   1   -42.213775    92.978004       -0.454     0.6498    16531514       347410     -0.003881     0.724375     1.380501
RNEWENG    1    -1326.327      124.873      -10.621     0.0001    20853011    190132177     -0.102875     0.564123     1.772663
RSOATL     1    -1058.154    91.317700      -11.588     0.0001     2059268    226298754     -0.201669     0.174718     5.723493
RNECENT    1    -1215.712    87.991728      -13.816     0.0001    88727327    321715552     -0.264620     0.144266     6.931634
RSECENT    1    -1321.784    99.507460      -13.283     0.0001    38766467    297374442     -0.187442     0.265771     3.762635
RNWCENT    1    -1174.438    91.586564      -12.823     0.0001    71694978    277134535     -0.232473     0.161021     6.210359
RSWCENT    1    -1501.712    91.444063      -16.422     0.0001  1077132540    454523605     -0.295214     0.163765     6.106321
RMOUNT     1    -1086.923      114.558       -9.488     0.0001   248105627    151718491     -0.102658     0.452056     2.212115
RPACIFIC   1   -50.556675    93.751112       -0.539     0.5897      490115       490115     -0.008326     0.222031     4.503867

TEST: J1X       NUMERATOR:     4.2E+08  DF:    1  F VALUE:  250.6730
                DENOMINATOR:   1685366  DF: 8681  PROB >F :   0.0001
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DEP VARIABLE: HOT      OUTPAT COST PER TOTAL OUTPAT VISIT

                    SUM OF          MEAN
SOURCE       DF    SQUARES        SQUARE       F VALUE       PROB>F

MODEL        36     777967     21610.181        53.412       0.0001
ERROR      8681    3512265       404.592
C TOTAL    8717    4290232

     ROOT MSE    20.114478     R-SQUARE         0.1813
     DEP MEAN    25.846337     ADJ R-SQ         0.1779
         C.V.     77.82332

                 PARAMETER      STANDARD    T FOR H0:                                             STANDARDIZED                  VARIANCE
VARIABLE   DF     ESTIMATE         ERROR  PARAMETER=0     PROB > !T!    TYPE I SS    TYPE II SS       ESTIMATE     TOLERANCE    INFLATION

INTERCEP    1    25.680995      1.659050       15.479         0.0001      5823913     96944.253       0.000000             .     0.000000
JALYR11     1     1.276376      1.195663        1.068         0.2858    30904.461       461.060       0.015039      0.475186     2.104439
JALYR12     1     1.914490      1.205444        1.588         0.1123    44591.077      1020.539       0.022198      0.482753     2.071454
JALYR13     1     2.519465      1.350739        1.865         0.0622    40745.782      1407.639       0.023649      0.586636     1.704635
JALYR20     1    -5.126759      1.242225       -4.127         0.0001      839.431      6891.321      -0.056091      0.510541     1.958705
JALYR21     1    -4.122902      1.201147       -3.432         0.0006     4525.583      4766.849      -0.048333      0.475627     2.102489
JALYR22     1    -3.001414      1.217505       -2.465         0.0137    10140.484      2458.824      -0.034278      0.487778     2.050111
JALYR23     1    -2.876272      1.308723       -2.198         0.0280    12236.184      1954.258      -0.028687      0.553511     1.806649
JALYR30     1    -7.180024      1.256020       -5.716         0.0001    99.507682     13221.358      -0.077748      0.509820     1.961477
JALYR31     1    -6.734192      1.209762       -5.567         0.0001      439.530     12536.862      -0.078716      0.471611     2.120392
JALYR32     1    -6.053892      1.222203       -4.953         0.0001     1827.177      9926.593      -0.069192      0.483291     2.069145
JALYR33     1    -6.016517      1.308976       -4.596         0.0001     3327.047      8547.605      -0.060509      0.544159     1.837699
JALYR40     1   -12.370467      1.297102       -9.537         0.0001    10443.973     36799.436      -0.130267      0.505467     1.978369
JALYR41     1   -11.622530      1.259203       -9.230         0.0001     7735.582     34468.915      -0.130145      0.474340     2.108193
JALYR42     1   -10.094686      1.270268       -7.947         0.0001     9710.027     25551.249      -0.111565      0.478489     2.089914
JALYR43     1   -10.520086      1.338902       -7.857         0.0001    19880.430     24978.059      -0.104260      0.535597     1.867074
PROPDUM     1     2.415381      0.715173        3.377         0.0007    85659.943      4614.943       0.036516      0.806710     1.239603
NEEDDUM     1    -1.973532      0.545398       -3.619         0.0003    29975.332      5297.603      -0.040508      0.752535     1.328842
OTEACHD     1     1.875862      0.772860        2.427         0.0152    19859.592      2383.513       0.029093      0.656399     1.523463
MAJTEACH    1    -3.423729      1.788711       -1.914         0.0556      294.137      1482.299      -0.019536      0.905275     1.104636
RURAL50     1   -10.754952      0.928114      -11.588         0.0001       134989     54328.978      -0.193062      0.339749     2.943348
RURAL99     1    -4.956847      0.894240       -5.543         0.0001    34716.781     12431.398      -0.087242      0.380703     2.626718
RURAL169    1    -5.480649      1.000998       -5.475         0.0001    34718.263     12128.724      -0.073094      0.529141     1.889857
RURAL170    1    -6.050706      1.247668       -4.850         0.0001    25013.514      9515.492      -0.055690      0.715139     1.398329
URBAN100    1     4.800055      0.999985        4.800         0.0001     4412.405      9322.306       0.065869      0.500821     1.996720
URBAN199    1     2.699539      0.910694        2.964         0.0030     4984.465      3555.099       0.041285      0.486157     2.056947
URBAN404    1     0.537406      1.080957        0.497         0.6191     0.995143       100.001       0.006071      0.632463     1.581120
URBAN504    1     0.139114      1.355328        0.103         0.9182     6.894415      4.262572       0.001170      0.725439     1.378477
URBAN505    1     2.744094      1.440595        1.905         0.0568     3537.699      1468.019       0.021734      0.724375     1.380501
RNEWENG     1     3.912380      1.934780        2.022         0.0432     2132.901      1654.385       0.026145      0.564123     1.772663
RSOATL      1    11.304219      1.414870        7.990         0.0001    11644.205     25826.493       0.185619      0.174718     5.723493
RNECENT     1     2.826837      1.363338        2.073         0.0382    48412.987      1739.451       0.053013      0.144266     6.931634
RSECENT     1    11.809155      1.541762        7.660         0.0001     3353.819     23736.714       0.144283      0.265771     3.762635
RNWCENT     1     2.404807      1.419036        1.695         0.0902    89501.181      1161.960       0.041012      0.161021     6.210359
RSWCENT     1    14.777571      1.416828       10.430         0.0001    17571.319     44013.844       0.250290      0.163765     6.106321
RMOUNT      1     9.167733      1.774959        5.165         0.0001      153.792     10793.567       0.074601      0.452056     2.212115
RPACIFIC    1    12.420396      1.452573        8.551         0.0001    29580.957     29580.957       0.176221      0.222031     4.503867

TEST: J1X          NUMERATOR:      1388.08   DF:     1    F VALUE:     3.4308
                   DENOMINATOR:    404.592   DF:  8681    PROB >F :    0.0640
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Regressions for Table 4

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DEP VARIABLE: TM_B     TOTAL MARGIN (B)

                      SUM OF          MEAN
SOURCE      DF       SQUARES        SQUARE       F VALUE        PROB>F

MODEL       36     12.719314      0.353314        28.604        0.0001
ERROR    11579       143.021      0.012352
C TOTAL  11615       155.740

    ROOT MSE        0.111138      R-SQUARE        0.0817
    DEP MEAN        0.037574      ADJ R-SQ        0.0788
    C.V.             295.784

                   PARAMETER      STANDARD   T FOR H0:                                           STANDARDIZED                   VARIANCE
VARIABLE   DF       ESTIMATE         ERROR PARAMETER=0    PROB > |T|    TYPE I SS    TYPE II SS      ESTIMATE     TOLERANCE     INFLATION

INTERCEP    1       0.079586   0.008266388       9.628       0.0001    16.399698      1.144900      0.000000             .      0.000000
JALYR11     1       0.028176   0.006209909       4.537       0.0001     0.162461      0.254282      0.059839      0.455979      2.193083
JALYR12     1       0.011637   0.006318308       1.842       0.06550.0004954214      0.041902      0.023853      0.472881      2.114697
JALYR13     1    -0.00608534   0.006249394      -0.974       0.3302     0.275348      0.011712     -0.012746      0.462886      2.160361
JALYR20     1       0.022187   0.006485648       3.421       0.0006 0.002554934      0.144545      0.043201      0.497299      2.010865
JALYR21     1       0.045086   0.006169456       7.308       0.0001     0.500782      0.659670      0.097628      0.444407      2.250189
JALYR22     1       0.017938    0.00632284       2.837       0.0046.00000162173      0.099416      0.036891      0.469050      2.131969
JALYR23     1    0.008587092    0.00619342       1.386       0.1656     0.081737      0.023744      0.018450      0.447882      2.232730
JALYR30     1       0.014431   0.006522763       2.212       0.0270     0.076953      0.060459      0.028057      0.493146      2.027795
JALYR31     1       0.047044   0.006209167       7.577       0.0001     0.405166      0.709047      0.101565      0.441357      2.265741
JALYR32     1       0.035842   0.006322862       5.669       0.0001     0.169684      0.396897      0.074395      0.460453      2.171773
JALYR33     1       0.012766   0.006207239       2.057       0.0397     0.041614      0.052243      0.027560      0.441631      2.264334
JALYR40     1       0.033426   0.006508447       5.136       0.0001 0.000196282      0.325795      0.067442      0.459916      2.174308
JALYR41     1       0.059839   0.006217661       9.624       0.0001     0.822586      1.144033      0.134437      0.406443      2.460367
JALYR42     1       0.038741    0.00635854       6.093       0.0001     0.247827      0.458514      0.082784      0.429592      2.327791
JALYR43     1    0.009234116   0.006250669       1.477       0.1396     0.073360      0.026957      0.020484      0.412493      2.424283
PROPDUM     1     0.00143999   0.003372687       0.427       0.6694 0.008625715   0.002251624      0.004307      0.779321      1.283167
NEEDDUM     1    0.006525783   0.002575436       2.534       0.0113     0.588377      0.079304      0.026297      0.736329      1.358088
OTEACHD     1    -0.00904104   0.003940515      -2.294       0.0218     0.777324      0.065022     -0.025311      0.651689      1.534474
MAJTEACH    1      -0.044019   0.009322253      -4.722       0.00010.0006154258      0.275402     -0.044035      0.911964      1.096535
RURAL50     1      -0.075014    0.00446265     -16.809       0.0001     3.003300      3.490034     -0.285402      0.275116      3.634827
RURAL99     1      -0.047887   0.004485748     -10.675       0.0001     1.040709      1.407653     -0.158325      0.360575      2.773350
RURAL169    1      -0.019447   0.005101212      -3.812       0.0001.00005262402      0.179516     -0.046853      0.525085      1.904452
RURAL170    1    0.003458065   0.006253366       0.553       0.5803     0.199130   0.003777176      0.005873      0.703258      1.421953
URBAN100    1      -0.052134   0.004853514     -10.741       0.0001     1.439605      1.425123     -0.141609      0.456319      2.191451
URBAN199    1      -0.020665   0.004598277      -4.494       0.0001     0.481278      0.249468     -0.057926      0.477391      2.094719
URBAN404    1    0.004227172   0.005576889       0.758       0.4485   0.00478535   0.007096504      0.008439      0.639800      1.562989
URBAN504    1       0.015663   0.007144316       2.192       0.0284 0.004018655      0.059369      0.022736      0.737420      1.356079
URBAN505    1       0.031896   0.007644385       4.172       0.0001     0.151322      0.215037      0.043337      0.735179      1.360212
RNEWENG     1    -0.00969481   0.009548998      -1.015       0.3100     0.086521      0.012732     -0.011639      0.603427      1.657201
RSOATL      1      -0.032392   0.006768206      -4.786       0.0001.00004444135      0.282913     -0.097806      0.189897      5.266008
RNECENT     1      -0.039231   0.006523092      -6.014       0.0001     0.259317      0.446765     -0.134837      0.157783      6.337802
RSECENT     1      -0.028715   0.007278879      -3.945       0.0001 0.002040468      0.192228     -0.069212      0.257661      3.881064
RNWCENT     1      -0.013375   0.006740623      -1.984       0.0473     0.638387      0.048631     -0.044626      0.156801      6.377500
RSWCENT     1      -0.051301   0.006733007      -7.619       0.0001     1.001634      0.717066     -0.171508      0.156527      6.388687
RMOUNT      1      -0.017243   0.007907737      -2.181       0.0292 0.003580466      0.058731     -0.031573      0.378295      2.643437
RPACIFIC    1      -0.025527   0.006924003      -3.687       0.0002     0.167880      0.167880     -0.069618      0.222413      4.496148

TEST: J1X          NUMERATOR:    .0561402   DF:      1   F VALUE:      4.5451
                   DENOMINATOR:  .0123518   DF:11579    PROB >F :     0.0330
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DEP VARIABLE: OPMARG

                     SUM OF         MEAN
SOURCE      DF      SQUARES       SQUARE      F VALUE       PROB>F

MODEL       36    16.383221     0.455089       41.161       0.0001
ERROR     9522      105.279     0.011056
C TOTAL   9558      121.662

    ROOT MSE       0.105149     R-SQUARE       0.1347
    DEP MEAN    0.006458823     ADJ R-SQ       0.1314
    C.V.           1627.997

                  PARAMETER     STANDARD   T FOR H0:                                                 STANDARDIZED                 VARIANCE
VARIABLE   DF      ESTIMATE        ERROR  PARAMETER=0   PROB > |T|   TYPE I SS     TYPE II SS        ESTIMATE     TOLERANCE    INFLATION

INTERCEP    1      0.084662  0.007919006       10.691       0.0001    0.398767       1.263730        0.000000         .         0.000000
JALYR11     1      0.027853  0.006567432        4.241       0.0001    0.399742       0.198863        0.062899     0.413152     2.420417
JALYR12     1   0.006672913  0.006563143        1.017       0.3093    0.012958       0.011429        0.015059     0.414267     2.413904
JALYR13     1   -0.00900353  0.006599034       -1.364       0.1725    0.070479       0.020582       -0.020077     0.419704     2.382631
JALYR20     1   0.006507689  0.007074944        0.920       0.3577    0.037275    0.009354517        0.012460     0.495272     2.019094
JALYR21     1      0.037173  0.006578036        5.651       0.0001    0.381181       0.353074        0.083713     0.414119     2.414763
JALYR22     1      0.010489   0.00660817        1.587       0.1125 0.001548748       0.027855        0.023355     0.419744     2.382405
JALYR23     1   -0.00461403  0.006584093       -0.701       0.4835    0.180450    0.005429789       -0.010376     0.414515     2.412457
JALYR30     1   0.008190052  0.007121057        1.150       0.2501    0.092372       0.014625        0.015633     0.491863     2.033086
JALYR31     1      0.043632  0.006638726        6.572       0.0001    0.364231       0.477585        0.097293     0.414700     2.411380
JALYR32     1      0.025791  0.006614221        3.899       0.0001    0.066335       0.168116        0.058042     0.410173     2.437995
JALYR33     1   0.008709323  0.006676889        1.304       0.1921    0.017888       0.018812        0.019126     0.422686     2.365821
JALYR40     1      0.019368  0.007297745        2.654       0.0080    0.101550       0.077880        0.036362     0.484134     2.065543
JALYR41     1      0.056851  0.006834586        8.318       0.0001    0.443335       0.765009        0.124107     0.408245     2.449508
JALYR42     1      0.030010  0.006803382        4.411       0.0001    0.037812       0.215130        0.066341     0.401768     2.489001
JALYR43     1      0.014978  0.006873112        2.179       0.0293    0.037248       0.052509        0.032252     0.414916     2.410126
PROPDUM     1      0.031576  0.003746759        8.428       0.0001    1.030216       0.785258        0.087956     0.834305     1.198603
NEEDDUM     1     -0.015179  0.002762205       -5.495       0.0001    2.623390       0.333858       -0.059891     0.765034     1.307132
OTEACHD     1     -0.011043   0.00374589       -2.948       0.0032    0.610639       0.096089       -0.034913     0.647952     1.543323
MAJTEACH    1     -0.062393  0.009373256       -6.657       0.0001    0.062439       0.489902       -0.065969     0.925272     1.080764
RURAL50     1     -0.084313  0.004539314      -18.574       0.0001    3.523167       3.814330       -0.295978     0.357886     2.794187
RURAL99     1     -0.051011  0.004427656      -11.521       0.0001    0.987759       1.467581       -0.173098     0.402590     2.483915
RURAL169    1     -0.022792  0.004944117       -4.610       0.0001 0.003622515       0.234969       -0.059642     0.542944     1.841811
RURAL170    1   0.001609907  0.005984273        0.269       0.7879    0.233921   0.0008001891        0.003045     0.709497     1.409450
URBAN100    1     -0.057268   0.00489996      -11.687       0.0001    1.554731       1.510264       -0.157799     0.498527     2.005909
URBAN199    1     -0.021087  0.004520529       -4.665       0.0001    0.319783       0.240578       -0.061796     0.517818     1.931179
URBAN404    1  -0.000754453  0.005244074       -0.144       0.8856    0.013671   0.0002288449       -0.001716     0.639130     1.564627
URBAN504    1   0.008064518  0.006697808        1.204       0.22860.0004855107       0.016029        0.013333     0.741129     1.349294
URBAN505    1      0.016406  0.007045787        2.329       0.0199    0.019144       0.059949        0.025961     0.731134     1.367739
RNEWENG     1     -0.030515  0.009125324       -3.344       0.0008    0.138071       0.123638       -0.039184     0.661879     1.510851
RSOATL      1     -0.055028  0.006149318       -8.949       0.0001    0.021564       0.885376       -0.174674     0.238515     4.192600
RNECENT     1     -0.068701  0.005834522      -11.775       0.0001    0.365884       1.532969       -0.256290     0.191828     5.212996
RSECENT     1     -0.040933  0.006785428       -6.033       0.0001    0.231571       0.402354       -0.100018     0.330594     3.024854
RNWCENT     1     -0.045925   0.00618298       -7.428       0.0001    0.273661       0.609971       -0.147862     0.229318     4.360749
RSWCENT     1     -0.083738  0.006182628      -13.544       0.0001    1.147423       2.028213       -0.272514     0.224482     4.454708
RMOUNT      1     -0.050509  0.007547487       -6.692       0.0001    0.014978       0.495159       -0.092796     0.472639     2.115779
RPACIFIC    1     -0.059270  0.006351835       -9.331       0.0001    0.962693       0.962693       -0.165304     0.289578     3.453298

TEST: JIX         NUMERATOR:    .0249367  DF:    1   F VALUE:    2.2554
                  DENOMINATOR:  .0110564  DF: 9522   PROB >F :   0.1332
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DEP VARIABLE: TDEBTR   TOTAL DEBT RATIO

                      SUM OF         MEAN
SOURCE       DF      SQUARES       SQUARE       F VALUE       PROB>F

MODEL        36      113.664     3.157329        34.091       0.0001
ERROR      8681      803.989     0.092615
C TOTAL    8717      917.653

    ROOT MSE        0.304327     R-SQUARE        0.1239
    DEP MEAN        0.474261     ADJ R-SQ        0.1202
    C.V.            64.16858

                   PARAMETER      STANDARD    T FOR HO:                                            STANDARDIZED                   VARIANCE
VARIABLE   DF       ESTIMATE         ERROR  PARAMETER=0   PROB > ITI    TYPE I SS    TYPE II SS        ESTIMATE    TOLERANCE    INFLATION

INTERCEP    1       0.529395      0.025101       21.091       0.0001     1960.886     41.196303        0.000000        .         0.000000
JALYR11     1    -0.00615343      0.018090       -0.340       0.7337     1.322013      0.010716       -0.004957     0.475186     2.104439
JALYR12     1    0.006285204      0.018238        0.345       0.7304     2.616803      0.010999        0.004983     0.482753     2.071454
JALYR13     1       0.017503      0.020436        0.856       0.3918     2.955534      0.067939        0.011234     0.586636     1.704635
JALYR20     1      -0.036430      0.018795       -1.938       0.0526     0.205731      0.347962       -0.027253     0.510541     1.958705
JALYR21     1      -0.064038      0.018173       -3.524       0.0004     0.023702      1.150011       -0.051331     0.475627     2.102489
JALYR22     1      -0.039001      0.018421       -2.117       0.0343     0.201773      0.415178       -0.030456     0.487778     2.050111
JALYR23     1      -0.042151      0.019801       -2.129       0.0333     0.225401      0.419708       -0.028746     0.553511     1.806649
JALYR30     1      -0.050470      0.019003       -2.656       0.0079     0.163245      0.653280       -0.037368     0.509820     1.961477
JALYR31     1      -0.061985      0.018303       -3.387       0.0007     0.134721      1.062175       -0.049541     0.471611     2.120392
JALYR32     1      -0.060928      0.018492       -3.295       0.0010     0.195099      1.005461       -0.047614     0.483291     2.069145
JALYR33     1      -0.043091      0.019804       -2.176       0.0296     1.185736      0.438460       -0.029632     0.544159     1.837699
JALYR40     1      -0.133947      0.019625       -6.825       0.0001     0.787801      4.314553       -0.096446     0.505467     1.978369
JALYR41     1      -0.132358      0.019051       -6.947       0.0001     0.915680      4.470170       -0.101339     0.474340     2.108193
JALYR42     1      -0.119501      0.019219       -6.218       0.0001     1.351299      3.580688       -0.090304     0.478489     2.089914
JALYR43     1      -0.113254      0.020257       -5.591       0.0001     1.627415      2.894875       -0.076746     0.535597     1.867074
PROPDUM     1       0.058797      0.010820        5.434       0.0001    29.396441      2.734634        0.060779     0.806710     1.239603
NEEDDUM     1      -0.151444    0.00825172      -18.353       0.0001    29.056292     31.195743       -0.212542     0.752535     1.328842
OTEACHD     1    0.001536462      0.011693        0.131       0.8955     0.629256   0.001599041        0.001629     0.656399     1.523463
MAJTEACH    1       0.015219      0.027063        0.562       0.5739     0.073291      0.029289        0.005938     0.905275     1 104636
RURAL50     1       0.030163      0.014042        2.148       0.0317     0.875584      0.427329        0.037022     0.339749     2.943348
RURAL99     1       0.013606      0.013530        1.006       0.3146     0.676042      0.093664        0.016374     0.380703     2.626718
RURAL169    1    -0.00318957      0.015145       -0.211       0.8332     1.171140   0.004107869       -0.002909     0.529141     1.889857
RURAL170    1      -0.035788      0.018877     . -1.896       0.0580     1.485245      0.332892       -0.022523     0.715139     1.398329
URBAN100    1       0.119485      0.015130        7.897       0.0001     2.081674      5.776385        0.112111     0.500821     1.996720
URBAN199    1       0.095972      0.013779        6.965       0.0001     7.327521      4.493290        0.100359     0.486157     2.056947
URBAN404    1      -0.018285      0.016355       -1.118       0.26360.0009991289      0.115771       -0.014124     0.632463     1.581120
URBAN504    1      -0.037735      0.020506       -1.840       0.0658     0.105992      0.313637       -0.021706     0.725439     1.378477
URBAN505    1      -0.045778      0.021796       -2.100       0.0357     0.169128      0.408560       -0.024792     0.724375     1.380501
RNEWENG     1      -0.154068      0.029273       -5.263       0.0001     4.476608      2.565539       -0.070398     0.564123     1.772663
RSOATL      1       0.057047      0.021407        2.665       0.0077     2.219618      0.657738        0.064050     0.174718     5.723493
RNECENT     1      -0.032146      0.020627       -1.558       0.1192     2.676564      0.224941       -0.041220     0.144266     6.931634
RSECENT     1       0.138213      0.023326        5.925       0.0001    10.287387      3.251495        0.115465     0.265771     3.762635
RNWCENT     1      -0.052506      0.021470       -2.446       0.0145     5.547362      0.553926       -0.061227     0.161021     6.210359
RSWCENT     1       0.047084      0.021436        2.196       0.0281     1.415940      0.446814        0.054527     0.163765     6.106321
RMOUNT      1       0.016775      0.026855        0.625       0.5322     0.078770      0.036138        0.009334     0.452056     2.212115
RPACIFIC    1     -0.0023212      0.021977       -0.106       0.9159 0.001033154   0.001033154       -0.002252     0.222031     4.503867

TEST: J1X        NUMERATOR:    .0132389   DF:    1   F VALUE:     0.1429
                 DENOMINATOR:  .0926148   DF: 8681   PROB >F :    0.7054
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DEP VARIABLE: EQTY      EQUITY

                   SUM OF         MEAN
SOURCE     DF     SQUARES       SQUARE      F VALUE      PROB>F

MODEL      36   53.515815     1.486550       32.268      0.0001
ERROR    9283     427.661     0.046069
C TOTAL  9319     481.176

    ROOT MSE     0.214637     R-SQUARE       0.1112
    DEP MEAN     0.543095     ADJ R-SQ       0.1078
    C.V.         39.52113

                PARAMETER     STANDARD   T FOR H0:                                     STANDARDIZED                VARIANCE
VARIABLE  DF     ESTIMATE        ERROR PARAMETER=0 PROB > |T|   TYPE I SS   TYPE II SS     ESTIMATE   TOLERANCE   INFLATION

INTERCEP    1     0.445545     0.017066      26.108     0.0001    2748.958    31.401112     0.000000           .    0.000000
JALYR11     1     0.033701     0.013013       2.590     0.0096    0.780009     0.308968     0.038600    0.430956    2.320420
JALYR12     1     0.031026     0.013004       2.386     0.0171    1.006241     0.262252     0.035609    0.429834    2.326481
JALYR13     1     0.036989     0.014627       2.529     0.0115    0.532346     0.294593     0.033501    0.545522    1.833107
JALYR20     1     0.032533     0.013903       2.340     0.0193    0.243780     0.252240     0.032383    0.499900    2.000401
JALYR21     1     0.073975     0.012911       5.730     0.0001    0.042310     1.512442     0.086591    0.419205    2.385469
JALYR22     1     0.064690     0.012877       5.024     0.0001 0.002890739     1.162715     0.076255    0.415561    2.406388
JALYR23     1     0.062543     0.014082       4.441     0.0001    0.041377     0.908758     0.061076    0.506291    1.975150
JALYR30     1     0.039876     0.013864       2.876     0.0040    0.314807     0.381123     0.040280    0.488174    2.048448
JALYR31     1     0.073801     0.013019       5.669     0.0001 0.006574564     1.480423     0.085606    0.419829    2.381920
JALYR32     1     0.074900     0.013009       5.758     0.0001    0.010837     1.527216     0.087108    0.418291    2.390679
JALYR33     1     0.059960     0.014199       4.223     0.0001    0.111502     0.821549     0.058151    0.504907    1.980564
JALYR40     1     0.073211     0.014348       5.103     0.00010.0002152648     1.199472     0.071494    0.487699    2.050446
JALYR41     1     0.102437     0.013466       7.607     0.0001    0.553351     2.665906     0.115159    0.417779    2.393610
JALYR42     1     0.098867     0.013490       7.329     0.0001    1.003143     2.474661     0.110593    0.420491    2.378171
JALYR43     1     0.084103     0.014441       5.824     0.0001    0.921231     1.562479     0.081079    0.493956    2.024471
PROPDUM     1    -0.046433  0.007965643      -5.829     0.0001   11.500318     1.565372    -0.062287    0.838520    1.192577
NEEDDUM     1     0.103470  0.005562615      18.601     0.0001   17.661157    15.939755     0.209811    0.752523    1.328863
OTEACHD     1    -0.012802  0.007967343      -1.607     0.1081 0.009143002     0.118938    -0.019532    0.647922    1.543396
MAJTEACH    1    -0.055814     0.018386      -3.036     0.0024    0.248524     0.424522    -0.031313    0.899780    1.111382
RURAL50     1     0.014703  0.009406565       1.563     0.1181    1.860704     0.112559     0.027410    0.311356    3.211758
RURAL99     1     0.012040  0.009409589       1.280     0.2007    0.820121     0.075427     0.020110    0.387626    2.579807
RURAL169    1  0.007222516     0.010646       0.678     0.4975    0.390753     0.021204     0.009029    0.540563    1.849923
RURAL170    1     0.025771     0.012811       2.012     0.0443    0.405028     0.186419     0.023475    0.703052    1.422370
URBAN100    1    -0.046847     0.010258      -4.567     0.0001    0.155603     0.960865    -0.064505    0.479929    2.083642
URBAN199    1    -0.053744  0.009725335      -5.526     0.0001    2.888833     1.406915    -0.075831    0.508478    1.966654
URBAN404    1     0.019706     0.011351       1.736     0.0826    0.010281     0.138864     0.021269    0.637965    1.567484
URBAN504    1     0.042933     0.014197       3.024     0.0025    0.212230     0.421308     0.034715    0.726557    1.376355
URBAN505    1     0.037353     0.014917       2.504     0.0123    0.180797     0.288858     0.028828    0.722354    1.384362
RNEWENG     1     0.122935     0.018749       6.557     0.0001    2.552186     1.980701     0.085523    0.562794    1.776850
RSOATL      1    -0.013752     0.013961      -0.985     0.3246    0.601164     0.044700    -0.021961    0.192610    5.191839
RNECENT     1     0.033968     0.013397       2.535     0.0112    0.848704     0.296161     0.062225    0.158963    6.290760
RSECENT     1    -0.068676     0.015302      -4.488     0.0001    4.360133     0.927946    -0.081664    0.289169    3.458181
RNWCENT     1     0.053861     0.013986       3.851     0.0001    2.793514     0.683197     0.089256    0.178226    5.610859
RSWCENT     1    -0.010785     0.014126      -0.764     0.4452    0.346423     0.026857    -0.016984    0.193498    5.168004
RMOUNT      1  0.003713267     0.016405       0.226     0.8209    0.031961   0.00236045     0.003540    0.391478    2.554425
RPACIFIC    1     0.017367     0.014335       1.212     0.2257    0.067623     0.067623     0.024146    0.241038    4.148718

TEST: J1X        NUMERATOR:     0.40972  DF:     1   F VALUE:     8.8936
                 DENOMINATOR: .0460692  DF:  9283   PROB >F :     0.0029
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DEP VARIABLE: LEVER    LEVERAGE

                     SUM OF         MEAN
SOURCE     DF       SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36     52.294855     1.452635       29.761       0.0001
ERROR    9283       453.108     0.048810
C TOTAL  9319       505.403

    ROOT MSE       0.220931     R-SQUARE       0.1035
    DEP MEAN       0.293951     ADJ R-SQ       0.1000
    C.V.           75.15911

                PARAMETER     STANDARD   T FOR H0:                                                  STANDARDIZED                  VARIANCE
VARIABLE  DF     ESTIMATE        ERROR PARAMETER=0  PROB > |T|   TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE    INFLATION

INTERCEP   1     0.415793     0.017566      23.670      0.0001     805.315    27.347463     0.000000        .         0.000000
JALYR11    1    -0.032464     0.013395      -2.424      0.0154    0.432333     0.286702    -0.036281     0.430956     2.320420
JALYR12    1    -0.030647     0.013385      -2.290      0.0221    0.539557     0.255876    -0.034320     0.429834     2.326481
JALYR13    1    -0.026435     0.015056      -1.756      0.0792    0.484717     0.150460    -0.023361     0.545522     1.833107
JALYR20    1    -0.021018     0.014311      -1.469      0.1420    0.292626     0.105280    -0.020413     0.499900     2.000401
JALYR21    1    -0.054272     0.013289      -4.084      0.0001    0.011719     0.814056    -0.061986     0.419205     2.385469
JALYR22    1    -0.048418     0.013254      -3.653      0.0003 0.004670426     0.651354    -0.055689     0.415561     2.406388
JALYR23    1    -0.041003     0.014495      -2.829      0.0047    0.075040     0.390591    -0.039070     0.506291     1.975150
JALYR30    1    -0.027871     0.014270      -1.953      0.0508    0.230418     0.186184    -0.027470     0.488174     2.048448
JALYR31    1    -0.058945     0.013401      -4.399      0.0001    0.033073     0.944394    -0.066715     0.419829     2.381920
JALYR32    1    -0.055803     0.013390      -4.167      0.0001    0.018613     0.847734    -0.063324     0.418291     2.390679
JALYR33    1    -0.038284     0.014615      -2.619      0.0088    0.106818     0.334926    -0.036228     0.504907     1.980564
JALYR40    1    -0.052201     0.014769      -3.535      0.0004    0.027040     0.609818    -0.049740     0.487699     2.050446
JALYR41    1    -0.066862     0.013861      -4.824      0.0001    0.372451     1.135761    -0.073342     0.417779     2.393610
JALYR42    1    -0.061748     0.013885      -4.447      0.0001    0.563179     0.965295    -0.067396     0.420491     2.378171
JALYR43    1    -0.062242     0.014865      -4.187      0.0001    1.050979     0.855755    -0.058548     0.493956     2.024471
PROPDUM    1  0.004301765  0.008199209       0.525      0.5998    4.142133     0.013436     0.005631     0.838520     1.192577
NEEDDUM    1    -0.101384   0.00572572     -17.707      0.0001   21.942844    15.303455    -0.200593     0.752523     1.328863
OTEACHD    1  -0.00758824  0.008200959      -0.925      0.3548    0.039286     0.041789    -0.011297     0.647922     1.543396
MAJTEACH   1    -0.025388     0.018925      -1.341      0.1798    0.013642     0.087834    -0.013898     0.899780     1.111382
RURAL50    1    -0.092162  0.009682381      -9.518      0.0001    7.901763     4.422318    -0.167640     0.311356     3.211758
RURAL99    1    -0.053275  0.009685494      -5.501      0.0001    2.176732     1.476786    -0.086823     0.387626     2.579807
RURAL169   1    -0.016302     0.010958      -1.488      0.1369    0.039092     0.108022    -0.019884     0.540563     1.849923
RURAL170   1    -0.011334     0.013187      -0.860      0.3901    0.012586     0.036058    -0.010074     0.703052     1.422370
URBAN100   1    -0.017452     0.010559      -1.653      0.0984    0.834803     0.133350    -0.023447     0.479929     2.083642
URBAN199   1     0.027279     0.010010       2.725      0.0064    1.014315     0.362450     0.037555     0.508478     1.966654
URBAN404   1    -0.024748     0.011683      -2.118      0.0342    0.037797     0.219009    -0.026062     0.637965     1.567484
URBAN504   1    -0.040168     0.014613      -2.749      0.0060    0.169581     0.368794    -0.031691     0.726557     1.376355
URBAN505   1    -0.039305     0.015355      -2.560      0.0105    0.188767     0.319837    -0.029599     0.722354     1.384362
RNEWENG    1    -0.132071     0.019299      -6.844      0.0001    3.178015     2.286005    -0.089649     0.562794     1.776850
RSOATL     1  -0.00264203     0.014370      -0.184      0.8541 0.000704474  0.001649891    -0.004117     0.192610     5.191839
RNECENT    1    -0.032046     0.013790      -2.324      0.0202    1.328379     0.263591    -0.057279     0.158963     6.290760
RSECENT    1     0.067668     0.015751       4.296      0.0001    3.236537     0.900928     0.078515     0.289169     3.458181
RNWCENT    1    -0.023629     0.014397      -1.641      0.1008    0.557584     0.131483    -0.038206     0.178226     5.610859
RSWCENT    1     0.015841     0.014540       1.089      0.2760    0.644490     0.057935     0.024340     0.193498     5.168004
RMOUNT     1     0.011586     0.016886       0.686      0.4926    0.394908     0.022980     0.010777     0.391478     2.554425
RPACIFIC   1    -0.029692     0.014755      -2.012      0.0442    0.197662     0.197662    -0.040281     0.241038     4.148718

TEST: JIX       NUMERATOR:      0.317536  DF:    1   F VALUE:    6.5055
                DENOMINATOR:    .0488105  DF: 9283   PROB >F :   0.0108
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DEP VARIABLE: LIQ       LIQUIDITY

                      SUM OF         MEAN
SOURCE     DF        SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36        403.443    11.206747       11.094       0.0001
ERROR    9283       9377.694     1.010201
C TOTAL  9319       9781.137

    ROOT MSE        1.005087     R-SQUARE       0.0412
    DEP MEAN        2.303047     ADJ R-SQ       0.0375
    C.V.            43.64165

                   PARAMETER     STANDARD   T FOR HO:                                            STANDARDIZED                   VARIANCE
VARIABLE  DF        ESTIMATE        ERROR PARAMETER=0   PROB > ITI    TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE     INFLATION

INTERCEP   1        1.974567     0.079914      24.709       0.0001    49433.500      616.746     0.000000          .        0.000000
JALYR11    1        0.152418     0.060938       2.501       0.0124    13.857538     6.319723     0.038720     0.430956      2.320420
JALYR12    1        0.185241     0.060894       3.042       0.0024     9.683665     9.348192     0.047154     0.429834      2.326481
JALYR13    1        0.186017     0.068496       2.716       0.0066     6.693990     7.450484     0.037367     0.545522      1.833107
JALYR20    1        0.155627     0.065106       2.390       0.0169     8.390833     5.772189     0.034358     0.499900      2.000401
JALYR21    1        0.268395     0.060457       4.439       0.0001     1.954866    19.909451     0.069682     0.419205      2.385469
JALYR22    1        0.261791     0.060298       4.342       0.0001     2.849299    19.041965     0.068445     0.415561      2.406388
JALYR23    1        0.261328     0.065942       3.963       0.0001     3.047320    15.865587     0.056602     0.506291      1.975150
JALYR30    1        0.217604     0.064920       3.352       0.0008     6.872404    11.349520     0.048754     0.488174      2.048448
JALYR31    1        0.309160     0.060964       5.071       0.0001     1.637682    25.979399     0.079540     0.419829      2.381920
JALYR32    1        0.365913     0.060916       6.007       0.0001  0.003794144    36.450007     0.094388     0.418291      2.390679
JALYR33    1        0.300999     0.066489       4.527       0.0001     2.061748    20.703537     0.064747     0.504907      1.980564
JALYR40    1        0.327126     0.067187       4.869       0.0001     0.799870    23.947863     0.070854     0.487699      2.050446
JALYR41    1        0.513293     0.063058       8.140       0.0001    15.919117    66.935714     0.127986     0.417779      2.393610
JALYR42    1        0.525527     0.063168       8.320       0.0001    40.847381    69.920389     0.130385     0.420491      2.378171
JALYR43    1        0.371817     0.067625       5.498       0.0001    26.267181    30.538320     0.079503     0.493956      2.024471
PROPDUM    1       -0.094491     0.037301      -2.533       0.0113    29.234166     6.482598    -0.028114     0.838520      1.192577
NEEDDUM    1        0.236880     0.026048       9.094       0.0001    83.030724    83.542633     0.106537     0.752523      1.328863
OTEACHD    1  0.0007250886     0.037309       0.019       0.9845     0.448287 0.0003815628     0.000245     0.647922      1.543396
MAJTEACH   1       -0.273591     0.086098      -3.178       0.0015     6.999051    10.200590    -0.034045     0.899780      1.111382
RURAL50    1       -0.113693     0.044048      -2.581       0.0099    16.279733     6.729981    -0.047009     0.311356      3.211758
RURAL99    1      -0.0027108     0.044062      -0.062       0.9509     2.972957  0.003823535    -0.001004     0.387626      2.579807
RURAL169   1        0.216137     0.049852       4.336       0.0001    30.508049    18.989210     0.059929     0.540563      1.849923
RURAL170   1        0.280228     0.059991       4.671       0.0001    29.878030    22.042365     0.056616     0.703052      1.422370
URBAN100   1       -0.115033     0.048034      -2.395       0.0166     9.765280     5.793525    -0.035131     0.479929      2.083642
URBAN199   1       -0.017795     0.045541      -0.391       0.6960     0.890186     0.154243    -0.005569     0.508478      1.966654
URBAN404   1 -0.000110353     0.053152      -0.002       0.9983     0.413059 .00000435457    -0.000026     0.637965      1.567484
URBAN504   1        0.091717     0.066480       1.380       0.1677     1.392205     1.922746     0.016449     0.726557      1.376355
URBAN505   1        0.092376     0.069854       1.322       0.1861     2.059616     1.766616     0.015813     0.722354      1.384362
RNEWENG    1       -0.085142     0.087795      -0.970       0.3322     1.279443     0.950072    -0.013137     0.562794      1.776850
RSOATL     1       -0.018192     0.065375      -0.278       0.7808     0.085358     0.078222    -0.006444     0.192610      5.191839
RNECENT    1       -0.049053     0.062735      -0.782       0.4343     4.905972     0.617604    -0.019930     0.158963      6.290760
RSECENT    1       -0.169169     0.071655      -2.361       0.0183    28.232361     5.630692    -0.044618     0.289169      3.458181
RNWCENT    1        0.034949     0.065495       0.534       0.5936     0.163539     0.287648     0.012845     0.178226      5.610859
RSWCENT    1        0.102135     0.066147       1.544       0.1226     7.577786     2.408460     0.035673     0.193498      5.168004
RMOUNT     1        0.099190     0.076818       1.291       0.1967     5.958256     1.684289     0.020973     0.391478      2.554425
RPACIFIC   1       -0.046374     0.067125      -0.691       0.4897     0.482162     0.482162    -0.014301     0.241038      4.148718

TEST: J1X        NUMERATOR:       10.86  DF:    1    F VALUE:    10.7503
                 DENOMINATOR:    1.0102  DF: 9283    PROB >F :    0.0010
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DEP VARIABLE: ROTA     RETURN ON TOTAL ASSETS

                  SUM OF         MEAN
SOURCE     DF    SQUARES       SQUARE      F VALUE       PROB>F

MODEL      36   1.571093     0.043641       35.098       0.0001
ERROR   12788  15.900876  0.001243422
C TOTAL12824   17.471969

    ROOT MSE    0.035262     R-SQUARE       0.0899
    DEP MEAN    0.024194     ADJ R-SQ       0.0874
    C.V.        145.7499

                PARAMETER     STANDARD  T FOR H0:                                           STANDARDIZED                  VARIANCE
VARIABLE  DF     ESTIMATE        ERROR PARAMETER=0    PROB > |T|   TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE    INFLATION

INTERCEP  1      0.033624  0.002382936       14.110       0.0001    7.506873     0.247566     0.000000            .     0.000000
JALYR11   1   -0.00240027  0.001883506       -1.274       0.20260.0002161635  0.002019318    -0.015791     0.463485     2.157566
JALYR12   1   -0.00095738  0.001880761       -0.509       0.6107 0.003466794 0.0003221958    -0.006317     0.462169     2.163710
JALYR13   1   0.004672364  0.001876386        2.490       0.0128    0.055347  0.007709881     0.030986     0.459581     2.175893
JALYR20   1   0.001248653  0.001961697        0.637       0.5245  0.00440688 0.0005037764     0.007580     0.501771     1.992942
JALYR21   1   -0.00143261  0.001877965       -0.763       0.44560.0002155419 0.0007235998    -0.009533     0.455708     2.194389
JALYR22   1   -0.00277379  0.001871661       -1.482       0.13840.0005623551  0.002730926    -0.018603     0.451672     2.213994
JALYR23   1  0.0005312195  0.001875659        0.283       0.7770 0.005187913 .00009973759     0.003547     0.453766     2.203781
JALYR30   1   0.001517579  0.001968324        0.771       0.4407 0.004424791 0.0007391423     0.009232     0.496331     2.014783
JALYR31   1   -0.00235961  0.001879757       -1.255       0.20940.0004392641   0.00195927    -0.015825     0.447790     2.233190
JALYR32   1  -0.000975639  0.001875649       -0.520       0.60300.0003797674 0.0003364293    -0.006576     0.445326     2.245544
JALYR33   1  0.0005519705  0.001874374        0.294       0.7684 0.005543041 0.0001078295     0.003724     0.444960     2.247395
JALYR40   1   0.003306302  0.001978082        1.671       0.0947    0.013171  0.003473881     0.020566     0.470074     2.127325
JALYR41   1   -0.00316133  0.001896029       -1.667       0.0955 0.001453999  0.003456748    -0.021652     0.422005     2.369643
JALYR42   1   -0.00386166  0.001896409       -2.036       0.0417 0.006355831   0.00515587    -0.026449     0.421835     2.370594
JALYR43   1   -0.00250969  0.001897417       -1.323       0.1860    0.010310  0.002175363    -0.017171     0.422277     2.368116
PROPDUM   1      0.018101  0.001017683       17.786       0.0001    0.704736     0.393359     0.169627     0.782449     1.278039
NEEDDUM   1   0.001305582 0.0007804247        1.673       0.09440.0005502137  0.003479882     0.016427     0.738114     1.354805
OTEACHD   1   0.003704629  0.001167706        3.173       0.0015    0.025739     0.012515     0.033051     0.655756     1.524957
MAJTEACH  1      0.018464  0.002569831        7.185       0.0001    0.084918     0.064188     0.064077     0.894753     1.117626
RURAL50   1   -0.00715488  0.001341692       -5.333       0.0001    0.179004     0.035360    -0.085016     0.280012     3.571272
RURAL99   1   -0.00103428   0.00135459       -0.764       0.4452 0.004502521 0.0007249053    -0.010596     0.369540     2.706071
RURAL169  1  -0.000928197  0.001528151       -0.607       0.5436 0.001241201 0.0004587399    -0.007062     0.526432     1.899582
RURAL170  1   -0.00333926  0.001890486       -1.766       0.0774 0.003268875  0.003879479    -0.017712     0.707775     1.412878
URBAN100  1   -0.00327762  0.001456975       -2.250       0.0245    0.013349  0.006292639    -0.027976     0.460178     2.173073
URBAN199  1   0.003245608  0.001377499        2.356       0.0185    0.037986  0.006902846     0.028711     0.479290     2.086419
URBAN404  1    -0.0037346  0.001667844       -2.239       0.0252 0.003037929    0.0062344    -0.023653     0.637806     1.567874
URBAN504  1   -0.00373538  0.002120946       -1.761       0.0782 0.002709338   0.00385682    -0.017313     0.736470     1.357829
URBAN505  1   -0.00519308  0.002235775       -2.323       0.0202    0.011008  0.006708303    -0.022955     0.728629     1.372440
RNEWENG   1     -0.014932  0.002852563       -5.234       0.0001 0.006391265     0.034070    -0.054708     0.651508     1.534901
RSOATL    1   -0.00515316  0.001922715       -2.680       0.0074    0.033668  0.008931748    -0.049064     0.212361     4.708965
RNECENT   1     -0.013689  0.001840941       -7.436       0.0001    0.040461     0.068752    -0.149510     0.176037     5.680609
RSECENT   1   -0.00374501  0.002095283       -1.787       0.0739    0.040948  0.003972282    -0.027914     0.291769     3.427369
RNWCENT   1     -0.017029  0.001920282       -8.868       0.0001    0.122195     0.097786    -0.174646     0.183493     5.449809
RSWCENT   1     -0.010640  0.001915395       -5.555       0.0001    0.043573     0.038369    -0.110060     0.181290     5.516010
RMOUNT    1     -0.015099  0.002250279       -6.710       0.0001    0.100294     0.055983    -0.089993     0.395639     2.527556
RPACIFIC  1  -0.000323762  0.001967369       -0.165       0.8693.00003367434 .00003367434    -0.002792     0.247270     4.044156

TEST: J1X        NUMERATOR:     9.5E-05  DF:     1   F VALUE:    0.0763
                 DENOMINATOR:  .0012434  DF:12788   PROB >F :    0.7823
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DEP VARIABLE: FASBED   FIXED ASSETS/BED

                     SUM OF          MEAN
SOURCE     DF       SQUARES        SQUARE       F VALUE       PROB>F

MODEL      36  8.32273E+12  231186980152       104.646       0.0001
ERROR   11579  2.55808E+13    2209239058
C TOTAL 11615  3.39035E+13

    ROOT MSE     47002.543        R-SQUARE        0.2455
    DEP MEAN     66260.276        ADJ R-SQ        0.2431
    C.V.          70.93623

                 PARAMETER      STANDARD   T FOR H0:                                                   STANDARDIZED                    VARIANCE
VARIABLE  DF      ESTIMATE         ERROR  PARAMETER=0   PROB > |T|    TYPE I SS     TYPE II SS        ESTIMATE     TOLERANCE     INFLATION

INTERCEP   1        102339      3496.012       29.273      0.0001 5.09992E+13   1.89311E+12        0.000000         .           0.000000
JALYR11    1      4979.337      2626.288        1.896      0.0580103827608618    7941474178        0.022665      0.455979      2.193083
JALYR12    1     11877.270      2672.132        4.445      0.0001284513550031   43647592822        0.052177      0.472881      2.114697
JALYR13    1     16790.731      2642.987        6.353      0.0001501084762018   89164502048        0.075377      0.462886      2.160361
JALYR20    1     -3109.750      2742.903       -1.134      0.2569   1520763900    2839701586       -0.012978      0.497299      2.010865
JALYR21    1      6178.694      2609.179        2.368      0.0179124138199799   12388772581        0.028675      0.444407      2.250189
JALYR22    1     14782.148      2674.048        5.528      0.0001373154145486   67511734904        0.065157      0.469050      2.131969
JALYR23    1     17714.467      2619.314        6.763      0.0001600799380859  101047071768        0.081575      0.447882      2.232730
JALYR30    1     -7503.506      2758.599       -2.720      0.0065   2119712065   16345337939       -0.031267      0.493146      2.027795
JALYR31    1     -2962.040      2625.974       -1.128      0.2594  15189779280    2810888895       -0.013706      0.441357      2.265741
JALYR32    1     72.369839      2674.057        0.027      0.9784  54433692209       1618141        0.000322      0.460453      2.171773
JALYR33    1      7225.444      2625.158        2.752      0.0059253967229576   16736349963        0.033433      0.441631      2.264334
JALYR40    1    -13281.357      2752.545       -4.825      0.0001  75695443371   51435003741       -0.057434      0.459916      2.174308
JALYR41    1     -9856.446      2629.566       -3.748      0.0002  61950130980   31039529957       -0.047461      0.406443      2.460367
JALYR42    1     -6094.273      2689.146       -2.266      0.0235  60219430298   11346388889       -0.027911      0.429592      2.327791
JALYR43    1     -3176.639      2643.526       -1.202      0.2295117270408918    3190151922       -0.015103      0.412493      2.424283
PROPDUM    1     -1536.700      1426.373       -1.077      0.2813  43929545592    2564215539       -0.009851      0.779321      1.283167
NEEDDUM    1     -5846.338      1089.200       -5.368      0.0001859993351965   63649499969       -0.050494      0.736329      1.358088
OTEACHD    1      1667.626      1666.518        1.001      0.3170557805547495    2212176470        0.010006      0.651689      1.534474
MAJTEACH   1     42385.326      3942.556       10.751      0.0001810088406971  255339447696        0.090876      0.911964      1.096535
RURAL50    1    -46882.219      1887.339      -24.840      0.0001913241177662   1.36320E+12       -0.382296      0.275116      3.634827
RURAL99    1    -40661.335      1897.107      -21.433      0.0001 1.05932E+12   1.01490E+12       -0.288132      0.360575      2.773350
RURAL169   1    -26961.227      2157.399      -12.497      0.0001252485887408  345033427708       -0.139217      0.525085      1.904452
RURAL170   1    -18505.980      2644.667       -6.997      0.0001  60482776707  108174534125       -0.067357      0.703258      1.421953
URBAN100   1    -27988.441      2052.643      -13.635      0.0001384857309626  410746111790       -0.162941      0.456319      2.191451
URBAN199   1     -8565.759      1944.698       -4.405      0.0001  32393544093   42861755805       -0.051461      0.477391      2.094719
URBAN404   1     -2025.835      2358.571       -0.859      0.3904   7923725307    1629868736       -0.008668      0.639800      1.562989
URBAN504   1      3540.743      3021.466        1.172      0.2413     66592706    3033863936        0.011016      0.737420      1.356079
URBAN505   1      6411.287      3232.955        1.983      0.0474   1398809827    8688282691        0.018670      0.735179      1.360212
RNEWENG    1    -16529.941      4038.451       -4.093      0.0001  11951793721   37013112491       -0.042535      0.603427      1.657201
RSOATL     1    -13134.041      2862.402       -4.588      0.0001  13647769456   46513421827       -0.084998      0.189897      5.266008
RNECENT    1    -14628.351      2758.739       -5.303      0.0001  86444807092   62117265675       -0.107759      0.157783      6.337802
RSECENT    1    -13907.762      3078.375       -4.518      0.0001  24498002890   45093514840       -0.071847      0.257661      3.881064
RNWCENT    1    -15941.777      2850.737       -5.592      0.0001208975351635   69087896730       -0.114000      0.156801      6.377500
RSWCENT    1    -12487.751      2847.515       -4.385      0.0001345212088202   42489244764       -0.089479      0.156527      6.388687
RMOUNT     1      5100.977      3344.331        1.525      0.1272    779025827    5139618757        0.020018      0.378295      2.643437
RPACIFIC   1      8207.041      2928.291        2.803      0.0051  17353509168   17353509168        0.047972      0.222413      4.496148

TEST: J1X          NUMERATOR:     5.6E+10  DF:     1   F VALUE:    25.2902
                   DENOMINATOR:   2.2E+09  DF:11579   PROB >F :    0.0001
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Medicare Margin

```
DEP VARIABLE: HOPRFDIS HOSP ONLY INPATIENT PROFIT/DISCHARGE

                       SUM OF          MEAN
SOURCE       DF       SQUARES        SQUARE       F VALUE       PROB>F

MODEL        36    3563913323      98997592       218.239       0.0001
ERROR     11579    5252476089        453621
C TOTAL11615       8816389412

    ROOT MSE          673.514      R-SQUARE        0.4042
    DEP MEAN          868.557      ADJ R-SQ        0.4024
    C.V.             77.54396

                     PARAMETER      STANDARD    T FOR H0:                                        STANDARDIZED                 VARIANCE
VARIABLE     DF       ESTIMATE         ERROR  PARAMETER=0   PROB > |T|   TYPE I SS   TYPE II SS     ESTIMATE    TOLERANCE    INFLATION

INTERCEP      1       1913.482     50.095419       38.197       0.0001  8763016793    661828648     0.000000            .     0.000000
JALYR11       1      38.397538     37.632881        1.020       0.3076    64888680       472242     0.010838     0.455979     2.193083
JALYR12       1        187.217     38.289790        4.889       0.0001   167717485     10844714     0.051002     0.472881     2.114697
JALYR13       1        380.268     37.872164       10.041       0.0001   361816438     45733244     0.105860     0.462886     2.160361
JALYR20       1       -174.283     39.303894       -4.434       0.0001     1254552      8919315    -0.045104     0.497299     2.010865
JALYR21       1       -138.538     37.387727       -3.705       0.0002     8895961      6228304    -0.039870     0.444407     2.250189
JALYR22       1     -80.087159     38.317258       -2.090       0.0366    24578137      1981664    -0.021891     0.469050     2.131969
JALYR23       1        103.283     37.532954        2.752       0.0059   111061315      3434962     0.029494     0.447882     2.232730
JALYR30       1       -231.905     39.528816       -5.867       0.0001      992777     15612954    -0.059925     0.493146     2.027795
JALYR31       1       -230.532     37.628384       -6.127       0.0001      328403     17026469    -0.066149     0.441357     2.265741
JALYR32       1       -129.726     38.317387       -3.386       0.0007     7729042      5199389    -0.035788     0.460453     2.171773
JALYR33       1       2.038538     37.616696        0.054       0.9568    49847439     1332.200     0.000585     0.441631     2.264334
JALYR40       1       -259.893     39.442060       -6.589       0.0001    15258953     19695252    -0.069694     0.459916     2.174308
JALYR41       1       -263.872     37.679860       -7.003       0.0001    27903768     22246475    -0.078793     0.406443     2.460367
JALYR42       1       -222.856     38.533601       -5.783       0.0001    39702045     15172671    -0.063293     0.429592     2.327791
JALYR43       1       -116.486     37.879888       -3.075       0.0021    58261341      4289666    -0.034345     0.412493     2.424283
PROPDUM       1        458.788     20.438933       22.447       0.0001   512623065    228560437     0.182388     0.779321     1.283167
NEEDDUM       1     -86.224218     15.607484       -5.525       0.0001   270571897     13844770    -0.046181     0.736329     1.358088
OTEACHD       1        133.670     23.880048        5.598       0.0001   289074512     14213112     0.049737     0.651689     1.534474
MAJTEACH      1        588.815     56.494098       10.423       0.0001   190573776     49277097     0.078287     0.911964     1.096535
RURAL50       1       -858.440     27.044256      -31.742       0.0001   448316343    457048651    -0.434088     0.275116     3.634827
RURAL99       1       -634.202     27.184233      -23.330       0.0001   193654213    246896072    -0.278685     0.360575     2.773350
RURAL169      1       -545.419     30.914027      -17.643       0.0001    93899484    141202272    -0.174647     0.525085     1.904452
RURAL170      1       -429.291     37.896236      -11.328       0.0001    27228743     58210954    -0.096895     0.703258     1.421953
URBAN100      1       -560.395     29.412943      -19.053       0.0001   167448532    164666166    -0.202312     0.456319     2.191451
URBAN199      1       -171.275     27.866176       -6.146       0.0001     8876699     17136670    -0.063809     0.477391     2.094719
URBAN404      1      -4.881479     33.796693       -0.144       0.8852   94059.481     9463.405    -0.001295     0.639800     1.562989
URBAN504      1      -2.203096     43.295509       -0.051       0.9594   81887.102     1174.557    -0.000425     0.737420     1.356079
URBAN505      1       -109.534     46.325996       -2.364       0.0181     9534332      2535969    -0.019780     0.735179     1.360212
RNEWENG       1       -778.492     57.868205      -13.453       0.0001    14878520     82095895    -0.124223     0.603427     1.657201
RSOATL        1       -425.544     41.016231      -10.375       0.0001    21618738     48828079    -0.170777     0.189897     5.266008
RNECENT       1       -675.195     39.530811      -17.080       0.0001    52176847    132336621    -0.308435     0.157783     6.337802
RSECENT       1       -470.737     44.110982      -10.672       0.0001     6006282     51660294    -0.150802     0.257661     3.881064
RNWCENT       1       -681.826     40.849077      -16.691       0.0001    54427899    126379182    -0.302355     0.156801     6.377500
RSWCENT       1       -670.969     40.802920      -16.444       0.0001   166769668    122663419    -0.298138     0.156527     6.388687
RMOUNT        1       -611.533     47.921945      -12.761       0.0001    88949200     73869184    -0.148823     0.378295     2.643437
RPACIFIC      1       -163.322     41.960385       -3.892       0.0001     6872290      6872290    -0.059201     0.222413     4.496148

TEST: JIX           NUMERATOR:     18116371   DF:      1    F VALUE:    39.9373
                    DENOMINATOR:     453621   DF:11579      PROB >F :    0.0001
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DEP VARIABLE: NPLHDIS  NET PROFIT-LOSS/TOT DISCHARGE FACIL

                      SUM OF         MEAN
SOURCE     DF        SQUARES       SQUARE      F VALUE      PROB>F

MODEL      36      194899398      5413872       34.137      0.0001
ERROR   11579     1836331881       158592
C TOTAL11615      2031231280

    ROOT MSE         398.236     R-SQUARE       0.0960
    DEP MEAN         159.920     ADJ R-SQ       0.0931
    C.V.            249.0219

                   PARAMETER     STANDARD    T FOR H0:                                              STANDARDIZED                  VARIANCE
VARIABLE   DF       ESTIMATE        ERROR  PARAMETER=0    PROB > |T|     TYPE I SS    TYPE II SS        ESTIMATE     TOLERANCE    INFLATION

INTERCEP    1        405.736    29.620444       13.698        0.0001     297071922      29756592        0.000000          .        0.000000
JALYR11     1        131.949    22.251588        5.930        0.0001       9541064       5576614        0.077595      0.455979     2.193083
JALYR12     1      63.514232    22.640006        2.805        0.0050       1973159       1248157        0.036048      0.472881     2.114697
JALYR13     1     -13.334330    22.393071       -0.595        0.5515        487981    56233.511       -0.007734      0.462886     2.160361
JALYR20     1      39.011236    23.239625        1.679        0.0932     42.851350        446891        0.021034      0.497299     2.010865
JALYR21     1        126.718    22.106634        5.732        0.0001       6393453       5210847        0.075977      0.444407     2.250189
JALYR22     1      51.493338    22.656247        2.273        0.0231        419002        819231        0.029323      0.469050     2.131969
JALYR23     1      29.016358    22.192503        1.307        0.1911       229.327        271115        0.017263      0.447882     2.232730
JALYR30     1      18.172705    23.372617        0.778        0.4369        887388    95874.819        0.009783      0.493146     2.027795
JALYR31     1        126.122    22.248929        5.669        0.0001       4514673       5096179        0.075396      0.441357     2.265741
JALYR32     1        103.535    22.656323        4.570        0.0001       3470691       3311868        0.059506      0.460453     2.171773
JALYR33     1      33.469464    22.242018        1.505        0.1324      4142.121        359111        0.020008      0.441631     2.264334
JALYR40     1      35.082078    23.321320        1.504        0.1325       1377544        358876        0.019600      0.459916     2.174308
JALYR41     1        131.295    22.279366        5.893        0.0001       2441083       5507705        0.081678      0.406443     2.460367
JALYR42     1      88.602511    22.784166        3.889        0.0001        332379       2398313        0.052426      0.429592     2.327791
JALYR43     1      38.917643    22.397639        1.738        0.0823        879954        478816        0.023905      0.412493     2.424283
PROPDUM     1      41.085374    12.085142        3.400        0.0007       1277570       1832952        0.034028      0.779321     1.283167
NEEDDUM     1      16.303608     9.228401        1.767        0.0773      12606761        494988        0.018192      0.736329     1.358088
OTEACHD     1       4.840868    14.119806        0.343        0.7317      26383777    18640.996        0.003753      0.651689     1.534474
MAJTEACH    1       -102.434    33.403858       -3.067        0.0022       1201906       1491338       -0.028374      0.911964     1.096535
RURAL50     1       -276.979    15.990741      -17.321        0.0001      29936537      47581433       -0.291797      0.275116     3.634827
RURAL99     1       -208.661    16.073507      -12.982        0.0001      18434735      26726440       -0.191026      0.360575     2.773350
RURAL169    1       -131.433    18.278861       -7.190        0.0001       2132490       8199520       -0.087680      0.525085     1.904452
RURAL170    1     -15.327912    22.407305       -0.684        0.4940       1419557    74210.760       -0.007208      0.703258     1.421953
URBAN100    1       -207.299    17.391299      -11.920        0.0001      21720460      22532600       -0.155916      0.456319     2.191451
URBAN199    1     -91.488167    16.476726       -5.553        0.0001       8666053       4889541       -0.071010      0.477391     2.094719
URBAN404    1      16.690043    19.983325        0.835        0.4036        130613        110627        0.009226      0.639800     1.562989
URBAN504    1      52.990150    25.599790        2.070        0.0385       115.541        679513        0.021299      0.737420     1.356079
URBAN505    1        145.384    27.391657        5.308        0.0001       3089955       4467637        0.054697      0.735179     1.360212
RNEWENG     1     -78.789502    34.216340       -2.303        0.0213       1779025        840910       -0.026193      0.603427     1.657201
RSOATL      1       -173.477    24.252097       -7.153        0.0001     22206.432       8114610       -0.145042      0.189897     5.266008
RNECENT     1       -222.945    23.373797       -9.538        0.0001       8328929      14428375       -0.212177      0.157783     6.337802
RSECENT     1       -154.561    26.081963       -5.926        0.0001        131885       5569297       -0.103156      0.257661     3.881064
RNWCENT     1       -122.680    24.153262       -5.079        0.0001       4014330       4091460       -0.113340      0.156801     6.377500
RSWCENT     1       -240.820    24.125970       -9.982        0.0001      15846136      15801426       -0.222933      0.156527     6.388687
RMOUNT      1       -123.260    28.335311       -4.350        0.0001     60444.388       3001039       -0.062494      0.378295     2.643437
RPACIFIC    1       -139.213    24.810357       -5.611        0.0001       4993126       4993126       -0.105130      0.222413     4.496148

TEST: J1X        NUMERATOR:     1637014   DF:     1    F VALUE:    10.3222
                 DENOMINATOR:    158592   DF:11579     PROB >F :    0.0013
```

CHANGES

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES--

MEDICARE'S PROSPECTIVE PAYMENT SYSTEM AND CHANGES IN THE STATUS OF ACUTE CARE HOSPITALS

Working Paper

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1.0 INTRODUCTION

1.1 Purpose of The Report

This report examines the hospitals that changed their acute-care status during the 1980s. It includes hospitals that closed but also ones that opened, merged with another acute-care hospital, split into two or more acute-care hospitals, became a non-acute-care facility, or changed from non-acute to acute-care status. By examining more than closures, this report is broader than other recently published analyses (Hospitals, April 5, 1988; Mullner, 1988). On the other hand, by focusing only on acute-care hospitals, it is narrower than other reports, because it ignores changes among specialty hospitals (except for those changing to or from acute-care status). This focus is appropriate, however, because this study is part of an evaluation of the impact of Medicare's prospective payment system (PPS) on hospitals.

One concern is the degree to which PPS may have contributed to an increase in closures of acute-care facilities. While the closure of hospitals that are an economically inefficient size may be desirable, serious reductions in patients' access to acute care, especially in rural areas, are not. The database assembled for this project permit these issues to be explored along with questions about the location, financial status, and utilization of hospitals that opened, merged, or became or changed from specialty hospitals during the 1980s. One file combined information from the American Hospital Association's (AHA's) annual surveys, Medicare cost reports, and HCFA's Provider of Service file to obtain the universe of all non-federal, short term, acute-care hospitals in the United States from 1980 through 1986. This file also records mergers, closures, and openings that occurred. The second file contains merged financial and utilizations data from AHA surveys and Medicare cost reports for the hospitals' reporting periods covered by TEFRA regulations and the first three years of prospective payment.

The construction of these computer files is described in Chapter 2. The reader should note that only short-term, acute-care hospitals are included here. Differences in definitions and in the identification of the year in which a hospital closed lead to some differences from other published reports (See Section 2.5). However, this report of closures does not differ greatly in the total industry capacity affected by acute-care closures and it adds the expansion due to openings to the picture. It also places the changes due to closures in a larger perspective of the general contraction occurring to the inpatient care side of the industry.

There are five ways hospitals can change their acute-care status: closing; opening; merging with another acute-care hospital; changing from being an acute-care facility to providing non-acute care such as rehabilitation, care for chronic conditions, etc.; and changing from provision of non-acute to acute care. Changes such as merging with non-acute-care facilities, opening or closing specialty units, joining a multi-hospital chain, or diversifying into non-hospital businesses (such as nursing homes) are important but are not the focus of this report. Chapter 3.0 describes hospitals that closed between 1980 and 1985.* Chapter 4.0 examines mergers between acute-care hospitals for 1980 through 1986. Hospital openings for the same period are presented in Chapter 5.0, while changes to and from acute-care status are the topics of Chapter 6.0.

1.2 Summary of Empirical Findings

The 1980s have been a time of many changes in the acute-care hospital industry. Table 1-1 presents, for each year, the number of closures, openings, mergers and other changes that occurred in both the states covered by the prospective payment system and those with waivers from the regulations.** The most numerous changes were closings: 228 in the non-waivered states between 1980 and 1985 and another 30 in the waivered ones. There were 89 hospital openings in 1980-1986, all of them in non-waivered states, and 54 mergers from 1981 to 1986, one quarter of which (14) occurred in the four waivered states. These 54 mergers involved a minimum of two hospitals each, so their impact on the industry involved well over 100 facilities. Only 25 hospitals became specialty hospitals between 1981 and 1986, two of which were in waivered states, while only five were recorded as changing from specialty to acute-care facilities. None of these was located in a waivered state.

With respect to time, hospital changes in the four waivered states appear to be spread fairly evenly across the years in question. Closures averaged five per year through 1985. Half of the 14 mergers were pre-PPS. In non-waivered states, however, closures and mergers increased significantly in more recent years: the former from 1984 on, the latter in 1985 and 1986. That is, closures fluctuated from 26 to 32 per year from 1980 to 1983 and then jumped to 57 a year for the first two calendar years under prospective payment. This is double the average for the prior four years. The number of mergers, on the other hand, fluctuated from one to nine, pre-PPS, then increased to double digits for the post-1983 period. The annual average was 1.5 times the pre-PPS average.

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*Closures in 1986 were not available at the time of this writing.

**Alaska and Hawaii are excluded from the reports on non-waivered states.

TABLE 1-1

STATUS CHANGES OF ACUTE-CARE HOSPITALS BY YEAR, NON-WAIVERED/WAIVERED STATES*

NON-WAIVERED

Year	Closures	Openings	Mergers	Change from Acute-Care	Change to Acute-Care
1980	26	1	b	b	b
1981	29	20	9	2	3
1982	27	9	1	8	1
1983	32	22	6	3	0
1984	57	15	5	4	0
1985	57	19	8	3	0
1986	a	4	11	3	1
TOTALS	228	89	40	23	5

WAIVERED

Year	Closures	Openings	Mergers	Change from Acute-Care	Change to Acute-Care
1980	5	0	0	0	0
1981	3	0	5	0	0
1982	7	0	0	1	0
1983	4	0	2	0	0
1984	5	0	0	1	0
1985	6	0	2	0	0
1986	a	0	5	0	0
TOTALS	30	0	14	2	0

*Excluding Alaska and Hawaii.

[a] Data on closures in 1986 not available at time of writing.
[b] Mergers and other changes could not be identified.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File
KLR297/81088

Time trends for openings and other changes in status are not evident. The annual average number of openings is the same (just under 13) for both pre- and post-PPS periods. Neither period had a steady flow of openings, however. The counts swing from single digits to over 20 and back again. In contrast, the number of hospitals changing from acute to specialty care is fairly constant at two to four annually, with the exception of 1982, when eight hospitals switched. These latter changes occurred the year before the announcement of PPS and cannot be attributed to it but came after that of the TEFRA regulations.

In sum, far more hospitals have disappeared from the acute-care industry during the 1980s than have been added to it. The greatest number is due to the hospitals that have closed. These reductions have been offset somewhat by hospitals opening, sometimes in the same locale.* What is the effect of these changes on the industry's capacity to provide acute-care? The next two tables summarize these changes in terms of the number of staffed beds available in the nation for each of the years under study.

The count does not include beds lost due to mergers or changes from acute-care status in 1980 or hospital closures in 1986. It also omits any gains in capacity from specialty hospitals becoming acute-care facilities in 1980. Additional years of data are required to distinguish industry changes in these years from omissions due to non-reporting. (See Chapter 2.0 for data cleaning procedures followed.)

Table 1-2 summarizes the changes in acute-care capacity for the non-waivered states, excluding Alaska and Hawaii. They are divided into the pre-PPS changes (1980-1983) and post-PPS ones (1984-86). The first column indicates how many acute-care beds were contained in all the acute-care hospitals that closed each year. That is, in 1980, closures accounted for a reduction of 2,365 beds. In that same year, one hospital with 100 beds opened. The net change in bed capacity was a reduction of 2,265 beds, which represented 0.3 percent of the total beds in that year.

Over the next three years, hospital openings added 319 more beds to the industry than closures took away. Table 1-1 showed that there were only 51 of the former and 88 of the latter. Therefore, closing hospitals were smaller than those that opened, pre-PPS. Other changes did not affect total capacity very much, except for the change of one 916-bed hospital to non-acute care in 1982. Therefore, taken all together, total industry capacity grew or shrank by less than 1,000 beds (sixth column) in each of these years, representing

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*For example, in one site a hospital reportedly sat empty for several years until an older facility with different owners in the same county closed. In another, a for-profit chain bought one hospital, closed it, then opened a new facility.

TABLE 1-2

CHANGES IN ACUTE-CARE BEDS FROM HOSPITALS' STATUS CHANGES PRE/POST PPS, NON-WAIVERED STATES*

	NUMBER OF BEDS GAINED (+) OR LOST (-) DUE TO:								
	Closures	Openings	Mergers	Change to Acute-Care	Change from Acute-Care	Total Change Due to Status Changes	Total Beds[a]	Percent Change in Beds Due to Status Change[b]	Total Percent Change in Beds
1980	-2,365	+100	d	d	d	-2,265	806,693	-.3%	---
1981	-1,263	+2,072	-66	+230	-129	+844	811,642	+.1	+.6%
1982	-1,222	+1,098	-7	+67	-916	-980	816,865	-.1	+.6
1983	-1,980	+1,614	-168	+65	-229	-698	820,408	-.1	+.4
Pre-PPS Subtotal	-6,830	+4,884	-241	+362	-1,274	-3,099	--	--	--
1984	-2,172	+1,134	-135	0	-332	-1,505	830,212	-.2	+1.2
1985	-2,802	+1,996	-57	0	-153	-1,016	804,254	-.1	-3.1
1986	c	+454	-587	+54	-324	-403	776,218	0	-3.5
Post-PPS Subtotal	-4,974	+3,584	-779	+54	-809	-2,924	---	---	---

*Excluding Alaska and Hawaii.

[a] This number represents all the beds in the year designated by the row.
[b] As percent of designated year. Other changes in beds (e.g., due to expansions) not included.
[c] Data on closures in 1986 not available at time of writing.
[d] Our database did not include the information necessary to identify 1980 mergers or 1980 service changes.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR297/81088
KLR449/82488

changes of only about 0.1 percent either way for 1981-83. At the same time the total number of staffed beds being reported by the hospitals grew 0.6 percent in 1981 and again in 1982, and 0.4 percent in 1983. These growth rates reflect the fact that expansion of existing hospitals' capacity in these years was greater than the reductions due to net decreases in the number of facilities.

The expansion of total industry capacity was most rapid during the first year of prospective payment. Total beds grew from 820,408 to 830,212, a 1.2 percent increase. This occurred despite a 0.2 percent decrease in beds occasioned primarily by the doubling of the number of closures (from 32 to 57 as seen in Table 1-1). These closures accounted for 2,172 beds, an average of 38 beds per hospital. The fifteen openings in 1984 added 1,134 beds (76 a piece), while mergers and other changes took away 467.

From this 1984 maximum, industry capacity shrank 3.1 percent in the next year to the lowest number of beds since the 1970s. Only four percent of this reduction in staffed beds (1,016 beds) was the net result of reductions in the number of hospitals. The other 25,000 beds were simply closed, an average of only five or six per acute-care facility. The percentage decline between 1985 and 1986 was even greater but of the 3.5 percent drop in industry capacity the amount due to closures is unknown. However, interviews with hospital executives suggest that the 776,000 reported staffed beds may significantly overstate capacity because hospital administrators fear that if their licensed beds are reduced they will be in weaker positions to respond to their competitors when the market environment changes. By preserving their licensed capacity, they hope to give themselves greater flexibility to create specialty units, to absorb the patient volumes from neighbors that fail or avoid any regulatory delays that might limit them.

Table 1-3 compiles the changes in industry capacity in the four waivered states. As in the states covered by PPS regulations, the greatest changes in staffed beds came after 1983 and were due far more to reductions in the average hospital's reported bedsize than to the effects of closures and mergers. The latter accounted for decreases of 0.1 to 0.7 percent in any one year's total beds while total reductions averaged five or six times that before PPS and ten times it, after 1983. The two exceptions occurred in 1982 and 1984 when temporary expansions of the average hospital's capacity appear to have taken place.

Of the changes in acute-care status, the most important cause of capacity reduction was the number of closures. The thirty closing hospitals (See Table 1-1) contained over 3,400 beds. Thus, they averaged over 100 beds put together apiece. More than 20 of these closures were New York hospitals (shown in Figure 3-1, Chapter 3.0). Massachusetts and New Jersey each had a few while Maryland had none.

TABLE 1-3

CHANGES IN ACUTE-CARE BEDS FROM HOSPITALS' STATUS CHANGES PRE/POST PPS, WAIVERED STATES*

	NUMBER OF BEDS GAINED (+) OR LOST (-) DUE TO:								
	Closures	Openings	Mergers	Change to Acute-Care	Change from Acute-Care	Total Change Due to Status Changes	Total Beds[a]	Percent Change in Beds Due to Status Change[b]	Total Percent Change in Beds
1980	-765	0	d	d	d	-765	146,077	-.5%	---
1981	-217	0	+82	0	0	-135	145,286	-.1	-.5%
1982	-939	0	0	0	-108	-1,407	145,205	-.7	-.1
1983	-240	0	+2	+108	0	-130	144,289	-.1	-.6
Pre-PPS Subtotal	-2,161	0	+84	+108	-108	2,317	---	---	---
1984	-638	0	0	0	-203	-841	152,671	-.5	+5.8
1985	-688	0	-126	0	0	-814	143,484	-.6	-6.0
1986	c	0	-213	+95	0	-118	139,009	-.1	-3.1
Post-PPS Subtotal	-1,326	0	-339	+95	-203	-1043	---	---	---

*Excluding Alaska and Hawaii.

[a] This number represents all the beds in the year designated by the row.
[b] As percent of designated year. Other changes in beds (e.g., due to expansions) not included.
[c] Data on closures in 1986 not available at time of writing.
[d] Our database did not include the information necessary to identify 1980 mergers or 1980 service changes.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File
KLR297/81088
KLR449/82488

Mergers and changes from acute care to specialty hospital status in these states contributed several hundred beds to the total reduction. These were not offset by significant industry expansion because there were no hospital openings during this time and only two hospitals became acute-care facilities. This differed from the non-waivered states, in which openings nearly offset the loss of beds from closures in most years.

Table 1-4 shows that these openings tended to occur in urban areas where they offset bed closures, on average (8,012 versus 8,187 beds). In rural areas, however, closing hospitals removed almost eight times as many beds as new hospitals replaced (3,167 versus 459). Mergers reduced urban acute-care capacity by six times as many beds (892 versus 148) but, given the greater number of urban beds, by twice as many in percentage terms. Few specialty hospitals became acute-care facilities in the 1980s and they added little to over all bed capacity. Over two thousand acute-care beds became special care beds in the same period, however. All of these were in urban facilities.

Across the nine Census divisions, three actually had net gains in the numbers of beds. These were the South Atlantic, West South Central, and Mountain states. All three are attributable to opening urban hospitals. The East North Central and Pacific states had the greatest decrease in capacity, over 2,000 beds in each case. These losses were due to large urban closures in both cases.

In summary, this preliminary examination of changes in the acute-care hospital industry indicates that the number of beds lost due to closures was virtually offset in urban markets as a whole by those gained from new hospitals. Rural areas suffered a larger net decrease in capacity, largely due to closures. However, in neither area were these losses comparable to the shrinking of capacity due to small reductions in staffed beds in all hospitals, on average. A special examination of rural markets where the closure of the only acute-care facility might pose a problem of access revealed that these were small hospitals with very low utilization. While patients would have to travel farther for acute care, most of the 25 counties were either adjacent to an MSA or next to a county with another hospital within 20-10 miles.

TABLE 1-4

CHANGES IN ACUTE-CARE BEDS BY STATUS CHANGE BY REGION, NON-WAIVERED STATES, 1980 - 1986*

	NUMBER OF BEDS GAINED (+) OR LOST (-) DUE TO:							
Region	Closures	Openings	Mergers	Change to Acute Care	Change from Acute-Care	Net Change in Beds	1980 Total Beds	Percent Change in Total Beds
Northeast								
Urban	-13	0	0	0	0	-13	18,977	-0.1%
Rural	-57	0	-95	0	0	-152	4,934	-3.1%
Middle Atlantic								
Urban	-476	+230	0	0	0	-246	46,523	-0.5%
Rural	-98	0	+7	0	0	-91	7,123	-1.3%
South Atlantic								
Urban	-759	+1,702	-170	+150	-377	+546	104,156	+0.5%
Rural	-423	+30	-1	0	0	-394	36,018	-1.1%
East North Central								
Urban	-1,902	+701	-457	0	-120	-1,778	149,949	-1.2%
Rural	-344	0	-2	0	0	-346	36,059	-1.0%
East South Central								
Urban	-327	+300	+10	+164	-173	-26	41,561	-0.1%
Rural	-822	+181	0	0	0	-641	28,487	-2.2%
West North Central								
Urban	-876	+522	-163	0	-253	-770	54,109	-1.4%
Rural	-436	+96	0	+35	0	-305	35,375	-0.9%
West South Central								
Urban	-1,270	+3,142	-47	0	-571	+1,254	76,449	+1.6%
Rural	-948	+99	-9	0	0	-858	28,219	-3.0%
Mountain								
Urban	-75	+784	0	0	0	+709	24,843	+2.8%
Rural	-290	+36	-48	0	0	-302	12,811	-2.4%
Pacific								
Urban	-2,489	+631	-45	+67	-589	-2,425	92,843	-2.6%
Rural	-199	+17	0	0	0	-182	8,257	-2.2%
TOTAL								
Urban	-8,187	+8,012	-892	+381	-2,083	-2,769	609,410	-0.4%
Rural	-3,617	+459	-148	+35	0	-3,271	197,283	-1.7%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File
KLR297/81088
KLR449/82488

2.0 DATA AND FILE CONSTRUCTION ISSUES

2.1 Data File Construction

2.1.1 Data Sources

This project required an accurate database containing all non-federal, acute-care hospitals in the United States that existed between the years 1980 and 1986. This file also records mergers, demergers, closures, or openings that occurred to any of these hospitals. This database is therefore the basis for many analyses of the structure of the acute-care hospital industry.

How many acute-care, general hospitals are there in the United States? The American Hospital Association's (AHA's) annual survey contains about 6,600 records of existing facilities. However, this number includes military, veterans', psychiatric, children's, and long-term care hospitals. It also omits some general hospitals. Therefore, to obtain the most complete count possible, we combined information from three sources.

Hospital records were obtained from the AHA annual surveys, Medicare Cost Reports (HCRIS) and HCFA's Provider of Service (POS) file. These three databases, merged for the years 1980-1985, included any available information on the hospital's name, the unique AHA hospital identification code (hospid), location, ownership, personnel, utilization, reporting procedures, expenses, admissions, number and type of beds, length of stay, Medicare participation, HMO participation, and affiliations. The 1986 AHA survey was added later. The final database also includes some demographic information on the population of the county in which each hospital was located from the Area Resource File (ARF).

From this file we subset a file, the universe file, which contained all the hospitals but with fewer variables. This file consisted of 38,580 hospital-level records sorted by state, hospid and year. The universe file included information on the AHA hospid, the hospital's name and location, the year of the record, the source of the record, the AHA control and service codes, a code for the type of facility as listed on the POS, and up to three estimates of each hospital's bedsize (one from each source).

2.1.2 Problems Defining the Universe File

The universe file presented a few problems. Some of the hospitals on the file had never been acute-care facilities. Other hospitals did not have records for all the years 1980-1986. In addition, some of the records lacked hospids.

2.1.2.1 Cleaning File of Federal and Exempt Records

To clean the database of any federal hospital records, we moved hospitals with federal control codes (1,755 records) to a separate file. Nine U.S. public service hospital records were added to this file, for a total of 1,764 records.

Non-acute care hospital records were placed in one of two files, depending on the number of years of data on file. An exempt facility file, made up of any hospids with a full six years of data but that did not fit our acute-care definition, was created. These non-acute-care records included records for nursing homes and chemical dependency, substance abuse, long-term care, or psychiatric units. The second file included all records for any non-acute-care hospitals included in the original file but with fewer than six years of data.

When there were more than six years of records for a hospital, the hospitals were contacted by telephone to find the reasons for the redundancies. In the majority of cases the excess records represented exempt units of acute-care facilities. These records were added to the appropriate exempt file and deleted from the universe file.

2.1.2.2 No Hospid

There were 2,662 records without AHA hospids. Each record was assigned a sequence number for identification. These records were manually matched by name, FIPS county code, and bedsize with records in the same state that had an identification code. We were also able to assign a few hospids from an internal HER file which listed hospitals by state and hospid. Some hospitals could not be matched because of name changes. These were resolved using two types of sources: the AHA guides (1978, 1982, 1984 and 1986) and the provider of service (POS) file from HCFA.

Through these methods, we were able to assign identification codes to 2,028 records that had been missing them. An additional five records were United States service hospitals and were placed on the federal file. The 629 records that still lacked hospids were given internal HER reference numbers.

To provide more information on the hospitals given HER reference numbers, we conducted extensive telephone searches. Calls were made to state and local hospital associations and to state licensure bodies. This helped us to determine whether hospitals had opened or closed, merged, or changed in some other way that affected their identification.

2.1.2.3 Missing Data

Compiling a complete computer file of acute-care, general hospitals was only the first step in the construction of the analytic file. Equally important for any study of the industry's structure was ensuring complete data for the 1980 through 1986 period. Some hospitals were missing important information for a few items; others lacked records for one or more entire years. These problems were resolved using various sources of information.

Padding Records for Missing Years

Some hospitals had incomplete sequences for the last years of the 1980-1985 period. If the hospital was open in 1986 according to the AHA survey data for that year, we assumed it had also been open during the intervening years. We padded the missing records with information from the last available year on file.

Hospitals that were complete except for 1980, 1981, or 1982 were checked against the AHA guides to see if they had been open prior to 1980. If the 1978 AHA guide showed that they were in business, we padded any years that were missing with information from the first year we had on file. The hospitals that were not listed in the AHA guides for the years in question were checked against the POS file to find their effective date for Medicare coverage. When the effective date was prior to the period in question, we assumed the hospital had been open, and we padded the missing years with information from the first available year on the file.

To clarify the status of the remaining incomplete sequences, we called state licensure agencies and a few state and local hospital associations. In the rare event we were unable to obtain information through this method, we contacted the hospital directly. We flagged the records of all the hospitals that had opened, closed, or merged in the 1980-1986 period. At this point the majority of opening hospitals on our file were flagged.

Control and Service Codes

Although the universe file consisted of complete six-year records, some lacked important information, such as the hospital's service and control code, because we had no AHA entry for that hospital. Therefore, we generated a list of records lacking either of these codes. By referring to the AHA guides (1978, 1980, 1982, 1986), we were able to pad these records with the codes they were missing. When the AHA did not list the hospital in question, we called state and local hospital associations, and state licensure agencies to obtain the needed information.

2.1.3 Mergers, Closures and Other Changes Affecting Industry Structure

One reason for hospital records to lack some years of information is that they did not exist during those years. Hospitals that closed, merged, or demerged during the 1980-1986 period had to be flagged and their records padded to reflect these changes. To check for any of these changes, we began with AHA lists of closure, demerger, and merger information published each year for the year just ended. We constructed a file for 1980 to 1986 which we checked against our database. This check allowed us to flag any closures, mergers, or demergers. This check also resolved any cases lacking records for the early years in the 1980-1986 period not resolved by the concurrent check in AHA guides (see 2.1.2.3 above). Closures and mergers required additional work.

2.1.3.1 Closures

In addition to the AHA list of closures, we had an internal closure file from the PPS-1 file sent to us by ABT Associates in 1987. We used this file to flag additional closures in our database. For all the records flagged as closures, we checked our records against the AHA's and Abt's year of closure information. When we had records for years after the closure date, we did further research to make sure the hospital had really closed (e.g., phone calls to state licensure bodies, cross-checking with AHA guides and POS Medicare termination dates). For hospitals missing records for one or two years previous to their closure dates, we researched the closure date and padded information from available years when necessary.

2.1.3.2 Mergers

To ensure that all the mergers listed by the AHA would be included in our database, we used a file listing all the hospids involved in these mergers to pull all the necessary sides of the merger from our database. In two cases we were unable to find records in our database for hospitals listed as part of a merger by the AHA. Abt staff were able to give us information on these hospital records from their more recent HCRIS files. We used this information to create records for the missing hospitals.

A merger file listed the hospids of the merger records, the year of the merger, and the bedsizes of the hospitals going into the merger, along with the bedsize of the institution resulting from the merger. We verified that we had the proper years of records for the hospitals going into a merger, and that the sum of the beds of the hospitals going into a merger were roughly equivalent to the beds listed in the first year of the merger result. (Merging hospitals can choose to close beds to rationalize costs or diversify into non-acute care.) If any of the merging hospitals were listed with records in years after the merger had occurred, we deleted the excess record or records. When the sum of the hospital beds of hospitals going into a merger was not similar to the bedsize of the merger result record, we referred to the AHA guides and our past records to reconcile the differences. In a few cases we made a special designation of A and B for a hospital that was reported by HCFA to be two distinct entities, whereas the AHA reported it as one facility with one hospid.

2.1.3.3 Other Structural Changes

Some of the AHA-designated mergers and demergers pertained only to the exempt units of acute-care hospitals. We did not want to include records of these structural changes within our merger file, because they did not affect the acute-care beds of the parent hospital. Yet, because a structural change had occurred, the AHA had given the acute-care hospital a new hospid, making two hospids for one hospital during 1980-1986. To simplify the records of the hospitals with two hospids, we deleted the least frequent of the two hospids and assigned an "x" in the last position of the most frequent hospid (e.g., 99999X).

Another problem that surfaced while cleaning the merger and demerger records was that a few times the AHA designated two hospitals as having merged when they were really just part of the same hospital system. In a few of these instances we had records for both the hospital and the system. We chose to delete the system records and keep the independent hospital sequences.

2.1.4 Bedsize Variables

Another problem we encountered on the universe file was that some of the bedsize numbers for the hospitals were questionable. As previously mentioned, we had three sources of bed size information: POS, HCRIS, and the AHA. Unfortunately, the POS's definition of a bed differs from the definition used by the AHA and HCRIS. The POS bed numbers reflect licensed beds and HCRIS's and the AHA's bed numbers represent staffed beds. Therefore, we constructed two variables, one for licensed beds and one for staffed beds. Though we had more complete information for licensed beds, we gave staffed beds priority in terms of defining bedsize. The reason for this choice is that staffed beds are a much more accurate indicator of the true bedsize of hospitals. Only when a hospital record lacked both HCRIS and AHA bed information did we rely on the POS licensed bed numbers.

To check potential discrepancies in bedsizes for individual hospitals throughout the 1980-1986 period, we created two lists from the universe file. The first contained hospitals whose bedsize between any two years in the period had changed by 33 percent or by more than 25 beds. The second list contained any hospitals where the source had changed at least once, and the bedsize had increased or decreased.

For both lists the hospital bed numbers were compared to those listed in the AHA guides (1978,1982,1984,1986). If the fluctuations in bed numbers listed in the file paralleled fluctuations noted in the AHA, the bed numbers were left unchanged. If the bed number sequences listed on the file differed greatly from the AHA bed number sequences, we made an assumption about which numbers were more accurate, or we phoned the state boards of licensure to clarify which numbers were more correct. In a few instances, the hospitals were found to be exempt throughout the period in question.

2.2 Definitional Issues

2.2.1 Hospital Units

Our goal in this study is to identify short-term acute-care hospitals, and then to provide an analysis of some of the changes in this industry. To fulfill this goal we had to differentiate between hospitals, health care facilities and hospital units. We first had to understand how our sources define hospitals, and/or health care facilities, and/or hospital units.

As previously mentioned, we obtained data from three sources: HCRIS, POS, and the AHA. All three sources report information for different segments of the health care industry, though some of their reporting overlaps. They all organize their reporting by designating numbers to the smallest entities with which they are concerned. For instance, HCRIS reports on acute-care Medicare certified units and designates a number for each unit. They include acute-care units within institutions such as prisons and schools. The POS, unlike HCRIS, not only reports on acute-care entities, but on all acute-care and non-acute-care providers of service; from clinics to hospitals, each provider is given a POS number. Though the AHA also reports on both acute-care and non-acute-care facilities, in contrast to HCRIS and the POS, the AHA reports information only for hospitals. They sometimes designate one number for a related group of hospitals. For instance, if an urban hospital has a satellite branch in a local suburb, the AHA may give the same number to both hospitals.

Unlike HCFA, we did not include acute-care units housed within an institution such as a prison, school or mental hospital within our database. We chose to omit this type of acute-care unit from our definition of an acute-care hospital because it does not provide acute-care services to the general public; care is only administered to institution inmates. Unlike the POS, we did not include clinics or non-acute-care facilities in our database.

Like the AHA, our database is made up solely of hospitals, but we limit our reporting to acute-care hospitals only. In contrast to the AHA we also tried to list each hospital individually, rather than reporting on groups of affiliated hospitals.

This study concentrates on acute-care hospitals. Many acute-care hospitals also offer non-acute-care services in special bed units. Unlike the parent acute-care hospital, these units are not covered under PPS. These exempt units provide such services as: long-term care, alcohol and chemical dependency programs, psychiatric services etc. In cleaning our acute-care hospitals' bed information, we subtracted exempt unit beds whenever possible. We used the American Hospital Association (AHA) Guides (1978-1986) as a basis for determining whether an acute-care hospital housed an exempt unit. The AHA noted nursing home, alcohol and chemical dependency rehabilitation, and psychiatric beds for its registered hospitals. Thus we were able to subtract these beds from the total to obtain the sum of acute-care beds. For those hospitals not registered with the AHA, but included in the AHA Guides, no information was given on exempt units. Therefore we could not ascertain whether these hospitals housed exempt units and hence could not correct their bed counts.

2.2.2 Acute-Care

In this study, we define acute care as short term care which includes general medical and surgical services or some other select specialty services. As defined by the American Hospital Association (AHA), short-term signifies that the "average length of stay for all patients is less than 30 days or over 50% of all patients are admitted to units where average length of stay is less than 30 days." Included within our definition of select specialty services are: obstetrics and gynecology; eye, ear, nose and throat; and orthopedic. Also, we included services defined by the AHA "as other specialties" (eg. arthritis, proctology and geriatrics etc.). Many hospitals defined as offering these other specialties also have general medical and surgical units.

Our definition of acute care does not include specialties such as psychiatric services, alcohol and chemical dependency services, tuberculosis and other respiratory disease services, rehabilitation services, childrens' services, mental retardation services, and chronic disease services. In addition, acute care does not include general medical and surgical services available in institutions such as prisons, schools or facilities for the mentally retarded.

2.2.3 Definition of Mergers and Demergers

The elements which can lead to changes in the structure of hospital markets, and therefore to changes in the potential for the exercise of market power include closures, openings, mergers, demergers, changes in service provided and changes in the size and nature of provider institutions. In this section we examine mergers and demergers.

Mergers

What is a merger? In analyzing the structure of hospital markets, it is important to define this concept. The Penguin dictionary of economic terms defines a merger as: "The fusion of two or more separate companies into one. Merger is a special form of combination where both companies want to join together and do so on roughly equal terms." Finkler and Horowitz (1985) define a merger as "a type of combination where organization A merges with organization B and the resulting combined entity is organization A. Separate from a merger is a consolidation which they define as "a combination where organization A combines with organization B and the combined entity is organization C."

Both of these definitions are to some extent inadequate. Neither say anything about what it means for two or more entities to merge into one. Is a merger just a financial arrangement or does it involve a restructuring of resources and operations within the hospitals involved? In this paper we wish to include the mergers that are likely to lead to a change in the competitive nature of markets, and to exclude the mergers which do not. Consequently, when a combination between two or more entities in the same market is accompanied by, for example, changes in management policies or a shifting of operating resources between the newly combined hospitals, we wish to record the fact that there has been a change in the market structure. However, if either two or more entities from different markets combine, or two or more entities in the same market combine without any accompanying changes in operating policies, then we do not want to record the combination as a merger.

In practice, exact distinctions between these two extremes are difficult to make because we have no measure of the degree to which different combinations involve changes in operating policies. Instead we have to classify combinations into different types and make assumptions about, for example, the degree of potential collusion by looking at the characteristics of each group.

Using AHA information we are able to identify one group of combinations between hospitals. According to the Finkler and Horowitz definitions these can be classified as both mergers and consolidations. We classified both types as mergers even though we have no hospital-specific information on changes in their operating policies, because in all cases the hospitals had independent records prior to the merger, and the merging hospitals were always in close proximity to each other (in the same state, or often the same county). This gives us confidence that such combinations might have altered the competitive nature of their local markets, or at least could have the potential to affect the nature of competition in the market. This assumption is supported by the Department of Justice Merger Guidelines which make it clear that in evaluating the antitrust implications of mergers the department will consider the actual and potential impact on consumer choice of changes in market structure.

Instances where affiliations or combinations between hospitals have not been flagged as mergers include: (1) where a hospital became a member of a multi-hospital system but had not otherwise been involved in merger activity; (2) other affiliations and links between hospitals which are not known to us but which might affect the competitive environment.

Independent hospitals which became part of a multi-hospital system during the period could well qualify as mergers or consolidations under our first two definitions of merger. However, this is clearly different from cases where two or more independent hospitals in the same area merge together. Multi-hospital systems often operate over large parts of the country, and do not have the potential to affect competition in local markets in the same way as mergers between competing local hospitals: System-related changes are not treated as mergers, whereas combinations between independent hospitals in the same locality are. The effect of multi-hospital chains will be examined elsewhere.

The other affiliations to which we refer are arrangements which clearly are not mergers or consolidations but which do have the potential for affecting competition. These might include, for example, referral agreements between hospitals, or arrangements for sharing of staff and high technology equipment between hospitals. Such arrangements may have a strong impact on competition or on the potential for competition, but unfortunately we have no measure of its extent.

Demergers

A demerger is the reverse of a merger. As such, a demerger is the splitting of a merged entity into two or more independent hospitals. As in the case of mergers we distinguish between demergers in local hospital markets and system-related changes: Demergers of local hospitals are more likely to affect competition, or the potential for competition than hospitals leaving a hospital system. Also, as with mergers, it is possible that changes are occurring for which we have no information, such as changes in referral arrangements. Very few demergers were identified.

2.3 The PPS Analytic File

The file of merged Medicare cost reports and AHA survey data was obtained from Abt Associates, Inc., as part of HCFA contract No. 500-85-0015. Its construction involved a great deal of computer processing.

2.3.1 Summary of HCRIS Data Processing

Tests for duplicate cost reports were conducted on all files. Duplicate reports had the same provider identification code, cost report beginning and end dates, and status. Cost report records identified as duplicates were manually reviewed to determine consistency of data, presence of key variables and worksheets, and general data availability. The record fulfilling the greater part of these criteria (i.e., the "best" record) was selected for each provider and the other was deleted from the file. In a few cases on the cost reports, it was impossible to choose a cost report according to the above criteria, and one of the duplicate reports was selected randomly. The TEFRA duplicates were found to have identical data.

Because the PPS master file contained multiple cost reports for the same provider and reporting dates, it was necessary to select the "best" of these multiple reports as indicated by the status code. A total of 2,138 reports having identical ID numbers and reporting dates but lesser status were deleted from the file (e.g., any "audited" report was selected over any "as submitted"). In addition, 163 cases with all data missing were deleted from the PPS1 file and 36 non-U.S. hospitals were deleted overall.

Edit checks on cost report begin-end dates were then conducted to determine and eliminate problem cases. Noted problems included missing or unreadable values, data outside of the fiscal years for the payment systems, and reports with overlapping dates on the longitudinal file. Cases with unreadable values were deleted. Where typographical errors were obvious, corrections were made to the dates. Otherwise, cases where assumptions on dates would have been ambiguous were deleted from the files. Other anomalies such as reports beginning or ending a few days outside of their fiscal year limits or overlapping with reports on other files were documented, but not corrected.

Missing values will be an important issue for analysts since HCFA treated them differently on each of the three files. The TEFRA master file has all zero values coded as missing. The PPS1 file contains both missing values and true zeros.

Since in some years HCFA did not require the submission of all worksheets, tests for the completeness of cost reports were conducted using frequencies for the number of missing worksheets and for specific missing worksheets for all cases. Most of the worksheets on all the files were missing for less than 5 percent of the cases. Problem worksheets on H180 included A-1 (42.8% missing) and G (74.4% missing). The TEFRA worksheets missing for a large percent of the cases was F (84.1% missing). The missing PPS worksheets were A-8 (89.0% missing), A-8-2 (22.9% missing), D-8 (14.8% missing) and F (83.7% missing). Over 50% of the cases in PPS1 were missing two worksheets while over 70% of the TEFRA cases reported one missing worksheet. The majority of the remaining cases reported either one or three missing worksheets.

2.3.2 The Structure of the PPS Analytic File

The analytic file is defined at the hospital level for each period between the hospital's fiscal year covered by TEFRA regulations and that covered by the third year of PPS. Only nonwaivered states are included. Because the hospitals' fiscal years could vary in length, all cost report flow variables, such as discharges, outpatient visits, costs, revenues, etc., were calculated as monthly values averaged across the fiscal year. AHA annual survey data items were also converted to monthly averages (for flow variables such as expenses, admissions, etc.) and matched to each hospital's cost report data according to the dates of the respective reports. Where AHA survey data time periods did not match those of the cost reports, a weighted average of the AHA data items from the two surveys covering the cost report period were matched to the latter.

In addition to these two data sources, hospital-level data items from Medicare's Impact file and county-level data items from the Area Resource File were also merged to the analytic file. Where these items were time dependent, they were matched to the year in which the mid-date of the hospital's Medicare Cost Reports for a given pay system (such as TEFRA or PPS-2) occurred.

2.4 Biased Sample Analysis

For the rural cost and profit analyses in this report, it was desirable to restrict them to the set of hospital's with data for all four time periods; TEFRA, and PPS-1 through PPS-3. Further, inclusion of PPS-3 data (for 1985-1986) was felt to be most desirable. The problem is that this reduces the number of hospitals in the PPS analytic file to 3,792 from the almost 4,600 hospitals with data in the TEFRA through PPS-2 time periods.

A biased sample analysis on the four-period file indicates that it underrepresents urban hospitals, particularly urban teaching hospitals, compared to a three-period file. Proprietary hospitals are also underrepresented as are those located in the Pacific, Mid-Atlantic, and South

Atlantic Census division. For rural hospitals, the four-period file contains 83-87 percent of the hospitals in the three-period (4,600 hospital) file. The lowest percentage is for hospitals with 50-99 beds that reported four periods of data. For analyses restricted to rural hospitals, the 2,047 facilities appear to be fairly representative of those in the nonwaivered states, although for any given data item, the possibility of missing data will greatly affect this.

2.5 Comparability to Other Reports

We found no other published reports on national trends for acute-care hospital openings or changes to or from acute-care status. Four citations cover hospital closures in the 1980s and one of these (Mullner, 1986) also presents some data on mergers. Because the AHA survey is the source of information for this report and the other papers that have been presented or published, differences in definitions are the main source of differences in the total counts of closures or mergers. Mullner distinguishes between mergers and consolidations, for example, while we treat them both as mergers when two or more facilities report as one entity but are not as mergers when the facilities report seperately but as part of the same multihospital system.

Another source of differences in the counts of closures is the fact that the AHA reported a number of hospitals as closing after they had actually closed. This is due to the fact that there is sometimes a substantial delay between a closure and the report to AHA. When calls to state liscensing agencies or hospital associations revealed a discrepancy between the closing date reported by AHA and that on file at the state, the latter was used for our database. This reduced the number of closures in 1980 and 1981 especially, because some of those closures had occurred in the 1970s. The timely reporting of closures appeared to improve from 1983 on. Other than these discrepencies, this report is very comparable to Mullner and McNeil (1986) who found that both urban and rural "community hospital" closures resulted in a bed loss rate of less than 1.5 percent.

What earlier publications lack is either the financial side of the closure or comparable numbers of openings and other changes. For example, we found that the loss of urban acute-care beds due to closures was virtually offset by gains due to urban openings. This completion of the picture is given here for the first time.

3.0 HOSPITAL CLOSURES

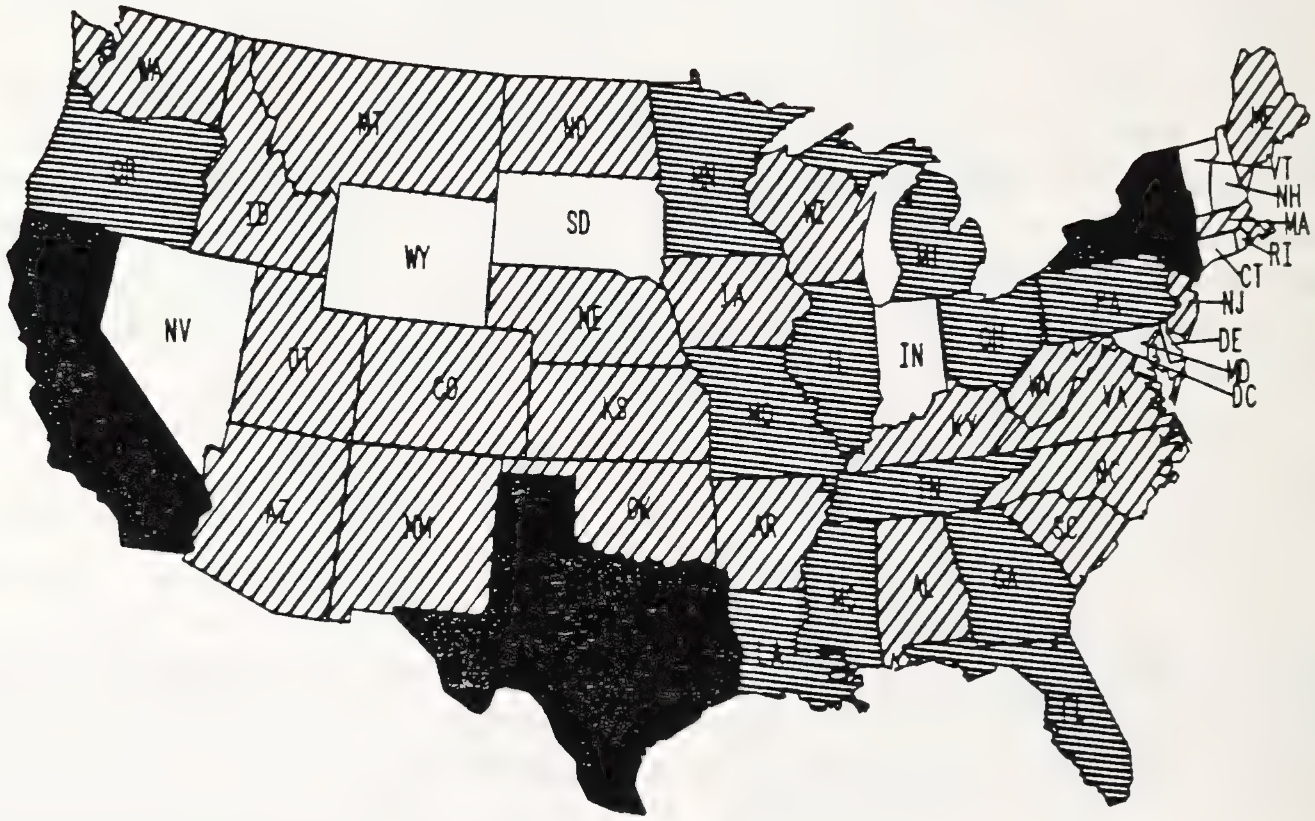
This chapter describes acute-care hospitals that closed between 1980 and 1985: when and where they closed, the loss of beds in their counties or MSAs, and their utilization and finances prior to closing. The picture is one of small hospitals with decreased utilization and financial viability shutting their doors. Rural closures tend to be in the Midwest; urban ones, in the Mid-Atlantic, West South Central and Pacific states, especially New York, Texas, and California. While closing hospitals represent over four percent of the industry total, they contained less than two percent of the nation's acute-care beds. They did not have a major share of urban markets but in rural ones they had a significant impact. Closing rural hospitals admitted roughly a third of all patients in their counties, on average. However, rural closures generally occurred in counties with at least one other acute-care hospital or that were located next to an urban center.

Section 3.1 is a discussion of the locations of acute-care closures during the 1980-85 period. Differences in the bedsizes of urban and rural closures is presented in 3.2. Section 3.3 presents similar information by the ownership categories of the closing hospitals while 3.4 relates the occupancy rates and outpatient activities of the failing facilities to their market shares. Section 3.5 presents the minimal information available about the finances of hospitals that closed during the prospective payment period. Finally, section 3.6 contains a special description just of the rural monopoly hospitals that closed during this period. These have been the objects of special concern, given the implications for access to care in rural areas, and therefore have received special emphasis in this report.

3.1 Location

The map of the United States in Figure 3-1 shows the relative numbers of closures by state (excluding Alaska and Hawaii). More than 80 percent of all states incurred some closure activity. New York, California, and Texas saw the greatest closure activity during the first half of the 1980s with over 20 closures in each state. These states are large and have more hospitals than any of the others, therefore there are more hospitals with the potential to close. States with 6 to 20 closures during this time tended to be located throughout the eastern half of the country, with the exception of Oregon. Those with fewer than six failing hospitals were located equally in the eastern and western halves of the country but included all states in New England, the North West Central, and Mountain Census divisions and all but

FIGURE 3-1
DISTRIBUTION OF CLOSURES BY STATE 1980-1985*



*Alaska and Hawaii are not included.

CLOSURES ■ OVER 20 ▤ 6-20 ▨ 1-5 □ NONE

Texas in the Southwest. States with no closures are primarily sparsely populated. Those in the West are larger in area than in the Northeast and the scarcity of hospitals in those states may account for the absence of failing hospitals.

In Table 3-1, urban and rural closures in nonwaivered states are shown by region, by year of closure. Of the 228 closures, slightly more than half (117) were urban hospitals. The majority of urban closures occurred in four Census divisions: the Pacific, West South Central, East North Central and South Atlantic. A separate breakdown by state, not shown, indicates that California and Oregon were the locations of most of the Pacific urban closures, while most of those in the West South Central region occurred in Texas and Louisiana. Among the East North Central states, Michigan, Ohio, and Illinois had the most urban closures. Those in the South Atlantic states were concentrated in Florida and Georgia.

The numbers of rural closures were also high in the West South Central (33) and East North Central states (11). Texas and Michigan accounted for many of these. The other two divisions of the Midwest saw a total of 34 rural closures in the early 1980s compared to 12 urban ones, reflecting the relatively rural nature of the populations in these states. On a state basis, most of the rural closures in the East South Central division occurred in Tennessee and Mississippi, while those in the West North Central states were concentrated in Minnesota and Missouri.

Consider the distribution of closures across the six years. More closures might be expected during the first four years compared to the last two in the analytic period, just because there was more time for them to happen. This occurred for urban closures in four of the nine Census divisions: the Mid-Atlantic, East South Central, West North Central, and Pacific. Furthermore, the pre-PPS number in the Pacific division, with eleven closures in 1982, was more than twice that for the post-1983 years. In only two of the other five Census divisions has the rate of urban closures since 1983 been higher than pre-PPS: the East North Central and West South Central divisions. In the others, the number of closures are too small to draw conclusions.

For rural closures, in five of the nine regions the number of failing hospitals has increased post-PPS, even though post-PPS the observation period is half as long. All four Midwestern divisions and the Pacific region have experienced marked increases in closures of rural hospitals in 1984 and 1985. Six of the eight rural closures in the Pacific states during the 1980s, half of those in the West North Central states, two-thirds of those in the Southwest, and seven of 11 and 18 closures in the Eastern Central states occurred in 1984 and 1985.

TABLE 3-1

LOSURES BY REGION IN NON-WAIVERED STATES*

	1980 Number of Closures	1981 Number of Closures	1982 Number of Closures	1983 Number of Closures	1984 Number of Closures	1985 Number of Closures	Total Number of Closures
Northeast							
Urban	0	0	1	0	0	0	1
Rural	1	1	1	0	0	0	3
Middle Atlantic							
Urban	0	3	1	0	1	1	6
Rural	0	1	0	0	1	0	2
South Atlantic							
Urban	1	2	1	2	5	4	15
Rural	1	5	0	1	1	2	10
East North Central							
Urban	1	0	2	3	7	6	19
Rural	0	2	1	1	4	3	11
East South Central							
Urban	2	0	0	1	0	2	5
Rural	3	4	1	3	4	3	18
West North Central							
Urban	2	0	0	2	2	1	7
Rural	0	1	0	7	3	5	16
West South Central							
Urban	3	2	2	4	7	7	25
Rural	2	3	3	2	8	15	33
Mountain							
Urban	0	0	1	0	1	0	2
Rural	1	2	1	2	1	3	10
Pacific							
Urban	8	3	11	4	8	3	37
Rural	1	0	1	0	4	2	8
TOTAL							
Urban	17	10	19	16	31	24	117
Rural	9	19	8	16	26	33	111

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service Files.

In the waivered states (Massachusetts, New York, New Jersey, and Maryland) five times as many closures occurred in urban as opposed to rural areas (see Table 3-2). This is explained by the predominance of closures in New York, which is heavily urbanized and was under very strict state regulations during the analytic period. Massachusetts and New Jersey are also very urbanized (New Jersey is considered totally urban by HCFA's definition) and no rural closures occurred in either of them.

3.2 Size

Urban closures between 1980 and 1985 included hospitals of all sizes, from those under 25 beds to those over 200 (Table 3-3). In contrast, no large rural hospitals closed and only 3 with 100 or more beds closed. For both urban and rural groups, more than four percent of the hospitals in existence in 1980 closed during the analytic period but accounted for a total loss of less than two percent of the beds available in 1980. This is due to the disproportionate number of small hospitals closing in either group.

Only ten percent of urban hospitals had fewer than 50 beds in 1980 but 40 percent of all urban closures were hospitals in these categores. Hospitals with 50 to 99 beds were also disproportionatley likely to close while urban hospital's with 100 beds or more (73 percent of all urban hospitals) accounted for only 27 percent of the closing urban facilities.

In terms of beds, the 19 urban hospitals with 6 to 24 beds represented 35.1 percent of all the beds in that size category in 1980. In other words, over one third of all beds in the smallest urban hospitals disappeared between 1980 and 1985 due to closures. Whether this category is likely to shrink more is addressed in sections 3.4 and 3.5, below.

Twelve percent of all the beds in hospitals with 25 to 49 beds in 1980 also disappeared by 1985 due to closures. In the other size categories, however, the impact on total capacity was much less, for example affecting only 0.3 percent of the beds in urban hospitals with over 200 beds in 1980, a category that accounts for over three quarters of all urban acute-care beds. Because few large hospitals closed, the net effect of the 117 urban closures, 4.5 percent of all urban hospitals in 1980, was to reduce metropolitan hospital capacity only 1.4 percent.

For rural closures in nonwaivered states, the situation was similar: predominantly small hospitals closed between 1980 and 1985. Of the 111 rural closures between 1980 and 1985, 85 percent were hospitals with fewer than 50 beds in 1980. The hospitals with 50 to 200 beds each, 50 percent of all rural facilities in 1980, accounted for only 15 percent of all the rural closures, while no rural hospital with 200 or more beds closed during this period.

TABLE 3-2

CLOSURES BY REGION IN WAIVERED STATES*

	1980 Number of Closures	1981 Number of Closures	1982 Number of Closures	1983 Number of Closures	1984 Number of Closures	1985 Number of Closures	Total Number of Closures	Average Number of Closures Per Year
Northeast								
Urban	0	1	2	0	0	1	4	1
Rural	0	0	0	0	0	0	0	0
Middle Atlantic								
Urban	5	1	5	3	4	3	21	4
Rural	0	1	0	1	1	2	5	1

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*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

TABLE 3-3

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL CLOSURES AND RESULTING BED REDUCTIONS BY HOSPITAL AND BY BEDSIZE, NON-WAIVERED STATES, 1980 - 1985*

URBAN CLOSURES

Bedsize in 1980	Total 1980 Hospitals	Percent of Total	Total Closing Hospitals	Percent of Closed Hospitals	Total 1980 Beds	Beds of Closing Hospitals	Percent of 1980 Beds
6 - 24	54	2.1%	19	16.2%	961	352	35.1%
25 - 49	212	8.2	28	23.9	8,185	992	12.1
50 - 99	442	17.0	39	33.3	32,383	2,441	7.5
100 - 199	678	26.1	25	21.4	97,852	3,406	3.5
200+	1,215	46.7	6	5.1	470,029	1,396	0.3
TOTAL	2,601	100.0	117	100.0	609,410	8,587	1.4

RURAL CLOSURES

Bedsize in 1980	Total 1980 Hospitals	Percent of Total	Total Closing Hospitals	Percent of Closed Hospitals	Total 1980 Beds	Beds of Closing Hospitals	Percent of 1980 Beds
6 - 24	302	11.3%	45	40.5%	5,564	771	13.9%
25 - 49	910	33.9	49	44.1	32,248	1,585	4.9
50 - 99	887	33.1	14	12.6	61,621	819	1.3
100 - 199	449	16.7	3	2.7	61,240	442	0.7
200+	134	5.0	0	0.0	36,605	0	0.0
TOTAL	2,683[a]	100.0	111	100.0	197,283[a]	3,617	1.8

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*Excluding Alaska and Hawaii.

[a] Missing data for one hospital that is included in totals.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service Files. KLR458/82488; KLR455/82488; KLR456/82488

The over all shrinkage of rural capacity was under 2 percent although the 111 closing facilities were 4.1 percent of all rural hospitals in 1980. Capacity in the smallest bedsize categories was reduced the most: 13.9 percent of beds in hospitals with only 6-24 beds, for example.

3.3 Ownership

Urban acute-care hospital markets are dominated by non-government, not-for-profit institutions which comprise over 1600 facilities compared to only 500 investor-owned, for-profits and 467 state and local government hospitals. The rural hospital industry, in contrast, is as dependent on government facilities as it is on private voluntary ones: 1,271 and 1,183, respectively in 1980. Proprietary hospitals numbered only 226 in 1980, less than ten percent of all rural facilities.

Given these distributions, we find in Table 3-4 that hospital closures in the 1980s were disproportionately for-profit hospitals, particularly in rural areas. There, 15.5 percent of all for-profit hospitals in existence in 1980 had closed as of 1985 compared to 2.6 and 3.4 percent of government and voluntary facilities. In urban markets the proportions were lower: only 10 percent of for-profit hospitals, 2.6 percent of local government facilities, and 3.1 percent of private voluntary hospitals closed.

For each of these ownership categories, the closing hospitals tended to be the smaller facilities, resulting in a lower proportion of the beds being lost for any given percentage of closing hospitals. That is, while 15.5 percent of all rural proprietary hospitals closed, they accounted for only 7.1 percent of the acute-care beds that existed in 1980. Urban proprietary hospital closures were even smaller, with the 10.1 percent that closed representing only 3.9 percent of the beds.

3.4 Utilization and Market Shares

One might expect hospitals that close to have low rates of utilization the year before closure because one reason for closing is that the hospital is no longer used. Cost report figures (See Table 3-5) suggest that this is indeed true more often than not: 26 percent of the urban and 30 percent of the rural hospitals for which we had the information had occupancy rates of 30 percent or less in the last year before they closed. At the other extreme, however, 21 percent of the urban and 12 percent of the rural hospitals that closed had occupancy rates of 60 percent or more in the year before they closed.

TABLE 3-4

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL CLOSURES AND RESULTING BED REDUCTIONS BY HOSPITAL OWNERSHIP, NON-WAIVERED STATES, 1980 - 1985*

	URBAN CLOSURES					
Hospital Ownership	Total 1980 Hospitals	Total Closing Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Closing Hospitals	Percent of 1980 Beds
Government, Non-federal	467	11	2.4%	101,699	1,203	1.2%
Non-Government, Not for Profit	1,627	51	3.1	440,071	4,513	1.0
Investor-Owned, For Profit	504	52	10.1	67,396	2,627	3.9
Missing	3	3	100.0	244	244	100.0
TOTAL	2,601	117	4.5	609,410	8,587	1.4

	RURAL CLOSURES					
Hospital Ownership	Total 1980 Hospitals	Total Closing Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Closing Hospitals	Percent of 1980 Beds
Government, Non-federal	1,271	33	2.6%	77,747	889	1.1%
Non-Government, Not for Profit	1,183	40	3.4	104,062	1,474	1.4
Investor-Owned, For Profit	226	35	15.5	15,307	1,087	7.1
Missing	3	3	100.0	167	167	100.0
TOTAL	2,683	111	4.1	197,283	3,617	1.8

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR449/82488; KLR455/82488; KLR456/82488

TABLE 3-5

AVERAGE UTILIZATION OF URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITALS AT TIME OF CLOSURE, NON-WAIVERED STATES, 1980-1985*

	URBAN CLOSURES				
Occupancy Rate Year Before Closure	Percent of Urban Closures	Mean Annual Admissions	Mean Percent of Total MSA Admissions	Mean Annual Outpatient Visits	Mean Percent of MSA Total
Low (x ≤. 3)	26%	1,022	.9%	5,705	1.7%
Medium (.3< x<.6)	53	1,850	1.1	43,361	2.7
High (x ≥ .6)	21	2,492	2.4	12,204	3.8
TOTAL	100	1,764	1.3	26,960	2.6

	RURAL CLOSURES				
Occupancy Rate Year Before Closure	Percent of Rural Closures	Mean Annual Admissions	Mean Percent of Total County Admissions	Mean Annual Outpatient Visits	Mean Percent of County Total
Low (x ≤. 3)	30%	509	38.7%	24,464	46.5%
Medium (.3< x<.6)	58	828	35.8	35,496	48.0
High (x ≥ .6)	12	1,611	43.4	5,631	40.4
TOTAL	100	833	37.9	28,107	46.9

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider Service File. KLR557/83188

The relatively small size of closing hospitals implies low numbers of admissions, however. The mean number of yearly inpatient cases in urban closures was only 1,764; for rural hospitals, only 833. The direct relationship between total admissions and occupancy suggests that larger hospitals had higher occupancy rates, in both urban and rural areas.

In urban areas, the small size and low occupancy of the closing hospitals implies that they had only small shares of their respective markets. This is borne out by Table 3-5: low occupancy urban hospitals had less than one percent of their MSAs' total admissions while the medium and high occupancy groups had 1.1 and 2.4 percent, respectively. Further, the closing urban hospitals had more outpatient than inpatient activity and had larger shares of the urban outpatient markets. However, they still averaged no more than one to four percent of the MSA totals.

In rural counties, closing hospitals, even those with low occupancy rates, played a larger role in their respective markets than was true for urban areas. For example, total admissions to the 27 rural hospitals with low occupancy represented 39 percent of the total admissions for those counties. The total outpatient visits for those hospitals (over 24,000 for each hospital) were over 46 percent of all the outpatient visits to hospitals in those rural markets (not counting out-of-county migrations to other hospitals).

Both urban and rural closures appear to affect a large number of people but more on the outpatient side than the inpatient. The mean number of outpatient visits was 27-28,000 per year but annual inpatient utilization averaged only 1,764 in urban closures and 833 in rural ones. The average outpatient activity varied across groups of hospitals defined by occupancy rates. For both urban and rural closures, those with occupancy rates between 30 and 60 percent had the highest numbers of annual outpatient visits just prior to closing (43,361 and 35,496, respectively). Low occupancy urban hospitals and high occupancy rural ones had the lowest average outpatient utilization (5600-5700). Given the small numbers of hospitals, many factors (such as the importance of rural physician clinics or competition with large urban medical centers) could explain this variation.

Only about 300 thousand patients may have had to seek alternative hospitals for admissions (the sum of all the urban and rural admissions to these hospitals). The 6.25 million outpatient visits (the sum across all urban and rural closures) are unlikely to be for as many patients, so somewhat less than that number of people will have been forced to seek alternative clinics or emergency rooms due to the closures. The numbers are fairly equally split between the urban and rural groups.

What share of their regional markets do closing hospitals represent? Using the ratio of each hospital's beds to the total in its MSA (if it is urban) or county (if it is rural), we see in Table 3-6 that the average market share was five percent for urban closures in the four years prior to the inception of PPS but seven for those occurring in the two years after. This is a small change compared to that for rural hospitals. Prior to PPS, rural closures had 35 percent of the beds in their counties but this rose to 45 percent after 1983. In the waivered states, the average share of urban closures fell to half its former value following PPS (6 percent versus 3 percent) but the rural share rose from 12 to 29 percent, more than doubling.

3.5 Financial Status

To examine the financial health of closing hospitals, one would ideally like to analyze the financial margins of these hospitals for a few years or more prior to their closures. Our financial data spans at most four periods of time for each hospital: their TEFRA through PPS-3 fiscal years. Therefore, the finances of many closures occurring between 1980 and 1985 cannot be analyzed, particularly those closing before 1983. Closures in 1983 and 1984 do not have more than one or two years of Medicare Cost Report financial data. Because of these data limitations, our description of the financial status of closing hospitals is suggestive of the larger picture.

Closing hospitals were more costly on a per case basis than the comparison group of hospitals that did not change their acute-care status during the 1980s (i.e., did not open, merge, etc.). Table 3-7 presents mean average total costs per case, unadjusted for cost factors such as relative wages, casemix, or teaching activities. Because closing hospitals are somewhat more likely to be in urban areas than the average facility, this may explain the higher costs per case. While urban hospitals tend to pay higher wages and generally handle the more severe cases, closing hospitals (both urban and rural) are small and these are not high-wage, tertiary facilities.

In TEFRA, hospitals that subsequently closed were about $500 more costly per case than the comparison group. This gap widened to $600-800 in the first two years of PPS. We know from the subsections above that closing hospitals generally had low to medium occupancy rates just before they closed. Seperate examinations of closures with high outpatient activity (not shown) also suggests a number of these facilities may have switched to clinic status for dental or mental health care when they closed the acute-care inpatient side of the business. These changes may account for the higher than average costs because of high overhead that could not be altered easily when inpatient utilization dropped precipitously.

Table 3-8 presents mean values for the percentages of operating and total hospital costs collected in each of the four fiscal years for each

TABLE 3-6

AVERAGE MARKET SHARE OF HOSPITALS THAT CLOSE, ALL STATES, 1980-1985*

	NON-WAIVERED STATES	
	PRE - PPS	POST - PPS
Average Market Share		
Urban	5%	7%
Rural	35%	45%

	WAIVERED STATES	
	PRE - PPS	POST - PPS
Average Market Share		
Urban	6%	3%
Rural	12%	29%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR656/100188

TABLE 3-7

AVERAGE COSTS PER CASE FOR CLOSING HOSPITALS, TEFRA THROUGH PPS-3

	MEAN PERCENT OF OPERATING COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	$2,735	$3,120	$3,508	$4,069
Hospital Closures Reporting for Each Year	3,220	3,992	4,183	4,371

Source: Medicare Cost Reports
EXK453/92788; EXK458/92788

TABLE 3-8

PERCENT OF COSTS COLLECTED BY CLOSING HOSPITALS, TEFRA THROUGH PPS-3

	MEAN PERCENT OF OPERATING COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	99.2%	101.9%	99.5%	97.2%
Hospital Closures Reporting for Each Year	84.8 (n=46)	79.2 (n=37)	73.5 (n=22)	92.4 (n=4)

	MEAN PERCENT OF TOTAL COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	104.0%	107.2%	105.1%	102.8%
Hospital Closures Reporting for Each Year	89.5 (n=45)	90.3 (n=36)	81.8 (n=22)	93.9 (n=4)

Source: Medicare Cost Reports
EXK224/9188; EXK301/9888

hospital. The number of hospital closures that reported financial data for each year dropped from TEFRA through PPS-3 because there was no report once they closed. Thus, the 46 hospitals reporting operating costs and patient revenues in TEFRA closed sometime after their TEFRA years. In addition, between PPS-2 and -3, a number of hospitals were also not included because of missing Medicare Cost Reports.

Acute-care hospitals that did not open, close, merge or otherwise change their acute-care status between TEFRA and PPS-3 collected 99.2 percent of annual operating costs through patient revenues, on average under TEFRA. Hospitals that closed after their TEFRA years collected only 84.8 percent of their operating costs as patient revenues in that year. The difference between these averages represents serious financial trouble for these hospitals as a group, prior to the beginning of prospective payment. As time went on, the disparity grew. Closing hospitals collected less than 80 percent of their operating expenses in PPS-1 and less than 75 percent in year two. This contrasts markedly with the 101.9 and 99.5 percent of operating costs collected by the comparison group of hospitals that were always acute-care facilities in the 1980s. In PPS-3, the gap narrows considerably but only four closing hospitals are represented so this is less likely to be an accurate picture than that for the earlier periods.

When non-operating revenues are considered, the disparity in the percent of costs collected is somewhat less. The average additional net revenue for the comparison group of hospitals is enough to place them in the black overall. While closing hospitals also received five to ten percent of their total costs as non-operating funds (donations, taxes, or investment income) they consistently ran losses of ten to twenty percent on average. Table 3-9 indicates that these losses were not strongly associated with any identified hospital characteristic. Only in the South Atlantic was the average closure more than breaking even prior to closure. These few profitable facilities may well have been subsidizing the inpatient operations from outpatient activity, however. Besides, urban/rural location and ownership are not predictors of pre-closure financial distress.

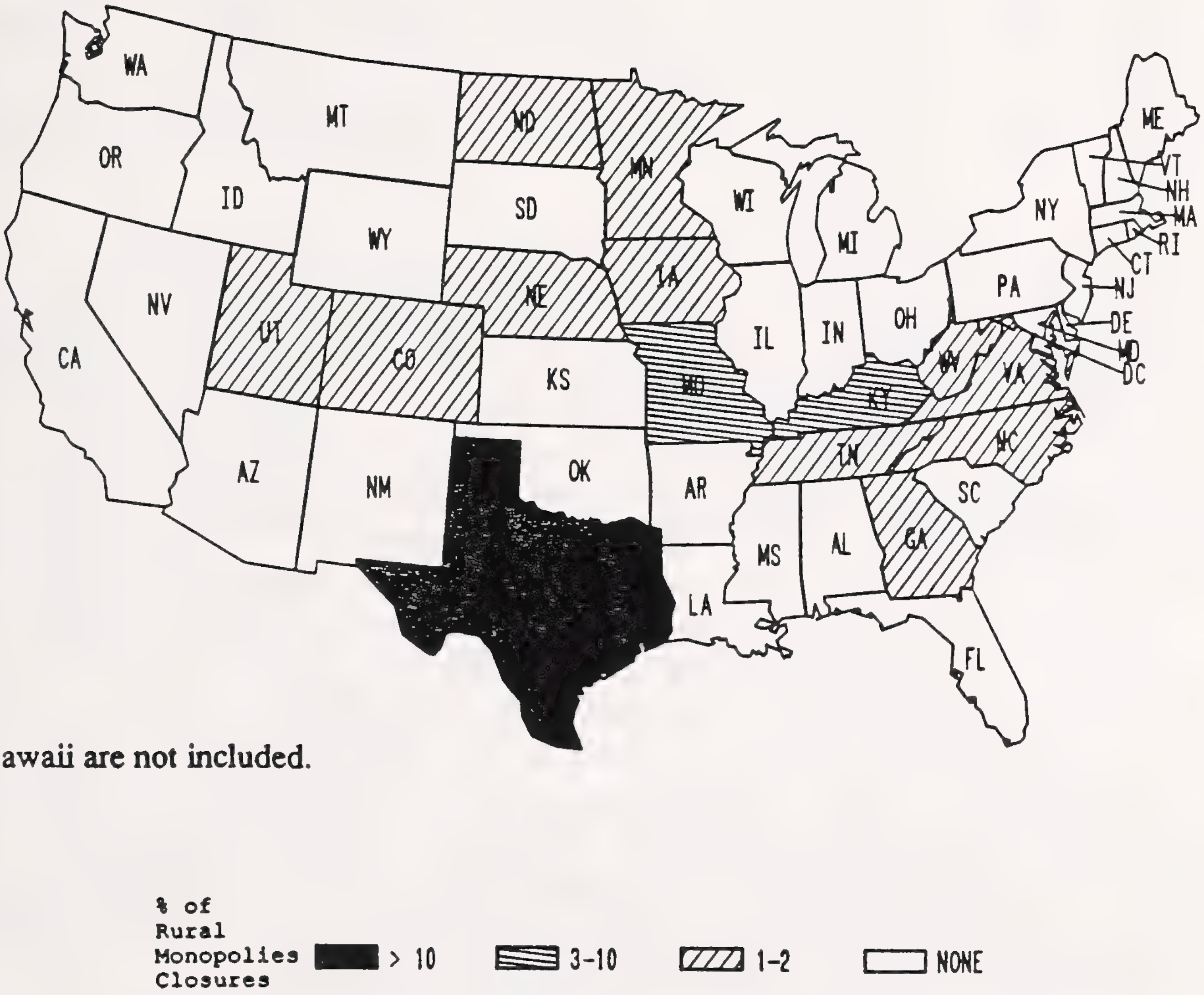
3.6 Rural Monopoly Closures

In 1980, 2709 rural acute-care hospitals existed. By 1985, 111 of these hospitals had closed. Of these, 25 were the sole providers of acute inpatient care in their counties. These counties are of special concern to policymakers because their residents presumably have farther to go for hospital care than they did when there was a hospital in the county.

This section explores issues unique to these counties affected by monopoly closures. How do these closures differ from other rural closures?

FIGURE 3-2

RURAL MONOPOLY CLOSURES BY STATE 1980-1985*



*Alaska and Hawaii are not included.

Why did these hospitals close? Were these facilities actually in a monopoly position or were they competing with hospitals in other counties? Is the population now being served by another facility?

Rural closures between 1980 and 1985 represent only 4 percent of 1980 rural hospitals and less than 2 percent of all rural acute-care beds. Monopoly hospitals were almost one-fourth of these, representing 1 percent of all 1980 rural hospitals, but only 0.2 percent of rural beds and an even smaller proportion of the total industry's capacity.

As shown in Figure 3-2, the Northeast was the only Census region without any rural closures. The largest percentage of these hospitals (44%) was in Texas, the state with the largest rural hospital industry. Although all of the counties were rural, more than half (52%) were adjacent to MSAs and virtually none were the stereotypic sole community provider located hundreds of miles from any urban area.

Monopoly hospital closures are smaller in size than other rural hospitals. Rural hospitals had 75 beds, on average in 1983. Closing monopoly hospitals had 24 beds, 27 percent less than the 33-bed average for all rural closures (not shown). Table 3-10 shows that closing monopolies were disproportionately in the smallest bedsize category. Sixty-one percent had between 6-24 beds and they accounted for one-third of rural closures with this bedsize (column 6). Monopoly closures in both the 25-49 and the 50-99 bedsize category each represent 14 percent of rural closures. No monopolies had over 100 beds.

Monopoly closures also differed from other rural closures in terms of ownership. State or local governments owned 56 percent of monopoly closures (column 5 in Table 3-10) compared to 30 percent of all rural closures. Furthermore, although only 2.6 percent of all rural closures were government hospitals, 42 percent of these were monopolies. Although there was a somewhat even distribution of rural closures across ownership catagories, most closings were proprietary hospitals (16%) and 20 percent of these facilities were sole providers for the county (column 6). Forty-seven percent of the rural hospitals in 1980 were government owned, but only 3 percent of these hospitals closed, and 42 percent of these closures were monopolies. Forty-four percent of rural hospitals were not-for-profit, but only 3 percent of these hospitals closed, and 5 percent of these were monopoly hospitals.

Areas that experienced a monopoly closure were more sparsely populated than areas with other rural closures. In 1980, counties with monopoly closures averaged 9,000 residents (Table 3-11). This is much lower than other rural areas where population averaged 33,400. In 1985, the population increased slightly in these monopoly counties to 9,500. However, this growth did not result in an increase in inpatient admissions.

TABLE 3-9

PERCENT OF COSTS COLLECTED BY CLOSING HOSPITALS BY CHARACTERISTIC, TEFRA - PPS-3[a]*

	PERCENT OF OPERATING COSTS COLLECTED				PERCENT OF TOTAL COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3	TEFRA	PPS-1	PPS-2	PPS-3
REGION								
New England	--	--	--	--	--	--	--	--
Mid-Atlantic	95.5%	72.4%	--	--	99.2%	76.7%	--	--
South Atlantic	95.8	100.9	109.1%	--	98.5	103.1	112.3%	--
East North Central	77.0	89.2	75.2	69.1%	80.9	90.9	73.2	71.8%
East South Central	87.9	82.8	74.5	--	93.8	88.8	82.1	--
West North Central	88.6	75.7	64.9	--	98.0	90.2	79.1	--
West South Central	89.0	72.5	62.1	88.7	92.3	93.8	70.7	89.3
Mountain	60.1	58.5	--	--	84.1	80.5	--	--
Pacific	77.5	73.8	81.6	--	77.5	82.7	88.0	--
LOCATION AND BEDSIZE								
Rural	84.2	72.9	70.6	--	91.3	88.7	84.8	--
Less than 50	83.7	69.1	70.6	--	90.9	85.3	84.8	--
Urban								
Less than 100	86.5	79.7	73.5	--	88.4	89.2	78.4	--
100-199	79.1	92.7	82.9	--	83.5	93.3	80.1	--
OWNERSHIP								
Non-federal gov't.	84.2	77.3	68.5	--	95.5	105.4	86.4	--
Voluntary	81.9	82.9	73.7	86.7	86.9	91.9	78.6	88.8
Investor-owned	89.4	75.8	77.0	98.1	89.0	81.0	81.5	99.0

*Excluding Alaska and Hawaii.

[a] No closing hospitals were identified as teaching institutions, sole community hospitals or RRCs. The numbers with large bedsizes were too small to present alone.

Source: Medicare Cost Reports. EXK461/92788

TABLE 3-10

COMPARISON OF MONOPOLY CLOSURES TO RURAL CLOSING HOSPITALS BY BEDSIZE AND OWNERSHIP, 1980-1985*

	Total Rural 1980 Hospitals (1)	Total Rural Closing Hospitals (2)	Percent of Rural 1980 Hospitals (3)	Closures as a Percent of Rural 1980 Beds (4)	Number of Closing Monopoly Hospitals (5)	Percent of Rural Closing Hospitals (6)
BED SIZE IN 1980						
6-24	302	45	14.9%	13.9%	14	33.3%
25-49	910	49	5.4%	4.9%	7	14.3%
50-99	887	14	1.6%	1.3%	2	14.3%
100-199	449	3	0.7%	0.7%	0	0.0%
200+	134	0	0.0%	0.0%	0	0.0%
TOTAL	2682	111	4.1%		23	20.7%
HOSPITAL OWNERSHIP						
Govt, non-fed	1271	33	2.6%	1.1%	14	42.4%
Non-govt, not-for-profit	1183	40	3.4%	1.4%	2	5.0%
Proprietary	226	35	15.5%	7.1%	7	20.0%
Missing	29	3			2	
TOTAL	2709	111	4.1%	1.8%	25	22.5%

*Excluding Alaska and Hawaii.

column (3) = (2) / (1)
column (4) - (calculation not shown)
column (6) = (5) / (2)

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
HRKLR513 82988

TABLE 3-11

CHARACTERISTICS OF MARKET CLOSURES*

	Counties of All Urban Hospitals	Counties of All Rural Hospitals	Counties of Monopoly Closures
Population '80 (in 100s)	7365.0	334.3	90.8
Population '84 (in 100s)	7598.0	334.9	95.3
Population over 65	82096.8	4412.0	1151.0
Density of Population (per sq mile)	2842.2	42.0	16.8
Per Capita Income'80	$8,926	$7,512	$7,298
Per Capita Income'84	$12,185	$10,143	$10,212
Number of Counties Adjacent to an MSA			52.0%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

Monopoly hospitals experienced declining, though fluctuating, admissions between 1980 and in the year of closure. Average admissions in 1980 were 2,137 (Table 3-12). Admissions in the year these hospitals closed was down 18 percent to 1,753. The two volunteer hospitals suffered the greatest drop, 29 percent. Government hospitals did not fare much better with a drop of 23 percent in utilization before closing. Proprietary hospitals only had an admissions loss of 1 percent. However, these investor-owned hospitals fluctuated in admissions more than the government hospitals. It is possible that after PPS they began heavy marketing in order to fill beds to increase profits and then closed due to low or no profitability in the area.

For a group of hospitals with a mean of 24 beds, declining admissions can have a significant impact on the financial health of the hospital. As admissions decline, these small facilities do not have enough volume to cover their overhead costs. As shown in Table 3-13, government-owned and proprietary hospitals (financial data was available for only 14 of the 25) were working with a negative operating margin during the TEFRA period. Although the operating margin indicates these hospitals were highly unprofitable, it is important to point out that they do not represent large dollar amounts. Generally, these large losses are only from 3,000 to 33,000. An average non-operating revenue of $13,947 per government hospital increased the operating margin from -53 percent to -7 percent. After PPS, operating margins for government hospitals improved. However, by PPS-2 three of the eight government hospitals in the sample had closed, and the amount of revenue necessary to bring the total margin to 8 percent had risen to $24,706.

The proprietary hospitals were also experiencing financial difficulty in TEFRA and their situation became worse with PPS. Not only were their total margins less than the government hospitals' (as low as -88 percent compared to -5 percent for government hospitals), but investor-owned hospitals did not receive much non-operating revenue to increase their total margin. While government hospitals received subsidies of up to $24,706, proprietary hospitals received a maximum of only $5,909.

Monopoly hospitals closed due to declining admissions and a number of years of negative operating and total margins. Although these losses may not have been monetarily large, investors in proprietary facilities did not have any reason to continue operating. With declining admissions, the government hospitals' administrations apparently decided to leave the servicing of the county up to neighboring areas.

Data at the hospital level suggest that patients may be using adjacent counties' facilities, but without a patient tracer it is not certain where the people of the monopoly closure counties are going. Out of the 13 counties with available data, 62 percent had adjacent counties that showed a slight increase

TABLE 3-12

HOSPITAL ADMISSIONS BY OWNERSHIP*

	AVERAGE ADMISSIONS[a]		
	1980	Closing	Percent Change
HOSPITAL OWNERSHIP			
Government	754	582	-23%
Not-for-profit	693	491	-29%
Proprietary	690	680	-1%
TOTAL	2137	1753	-18%
MEAN	7.8%		
MEDIAN	23.7%		

*Excluding Alaska and Hawaii.

[a] Admissions calculated from 1980 and year of closure.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. HRKLR513/82988

TABLE 3-13

FINANCIAL STATUS OF CLOSING HOSPITALS UNDER TEFRA AND PPS*

	Government Owned	Proprietary
TEFRA		
Operating Margin	-53.41%	-23.41%
Total Margin	-7.21%	-12.72%
Net Patient Revenue	$81,480.78	$92,056.40
Total Non-Patient Revenue	$13,946.67	$4,455.00
PPS		
Operating Margin	-47.77%	-105.76%
Total Margin	-5.02%	-88.36%
Net Patient Revenue	$88,238.13	$73,083.75
Total Non-Patient Revenue	$20,703.75	$5,909.25
PPS2		
Operating Margin	-38.32%	-26.43%
Total Margin	-7.87%	-15.63%
Net Patient Revenue	$106,416.20	$210,700.50
Total Non-Patient Revenue	$24,706.00	$3,526.50

---

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. HRKLR566/83188 in hospital admissions that could be attributed to the closure of these hospitals. However, many hospitals in adjacent counties also show a decrease in admissions, leaving this conclusion questionable.

Despite the closing of these monopoly hospitals, few counties are in a situation where needs may be unserviced. Half (52%) of the counties are adjacent to MSAs and inspection of road maps show almost all are near cities with medical services. However, the closure of a sole health care facility in a county should give rise to concern. Not only do patients have to travel farther for medical services, but the health education of the area and physician familiarity with the patients are aspects of the services that will most likely not be provided by adjacent county hospitals.

4.0 HOSPITAL MERGERS

This chapter describes acute-care hospitals that merged between 1980 and 1986 and the facilities that were results of these mergers. It shows when and where mergers occurred, the loss or gain of beds in their counties or MSAs, the ownership of the hospitals involved in mergers, and the utilization and financing of both the groups of hospitals that merged and the hospitals left after the merger. The picture is one of relatively large hospitals merging in urban areas and medium-sized hospitals merging in rural areas. The rural mergers tend to be in the East North Central and Mountain regions while the urban mergers are concentrated in the East North Central, Pacific and West North Central regions. The mergers were overwhelmingly among voluntary not-for-profit hospitals. Only one merger involved investor-owned facilities. While the merging hospitals represent only 3% of the industry total, they contained almost 4% of the nation's acute-care beds. They did not affect a major share of either the urban or rural markets, although they had some impact on the total number of beds.

Section 4.1 is a discussion of the locations of acute-care mergers during the 1980-1986 period. Differences in the bedsizes of urban and rural merging hospital groups and their merger results are presented in 4.2. Section 4.3 presents the ownership categories of the merging hospital groups and compares the number of mergers in each category to the number of hospitals in 1980. Section 4.4 relates occupancy rates, admissions, and outpatient visits of hospitals involved in mergers to market shares. Finally, section 4.5 describes available cost and financial data for merger result hospitals.

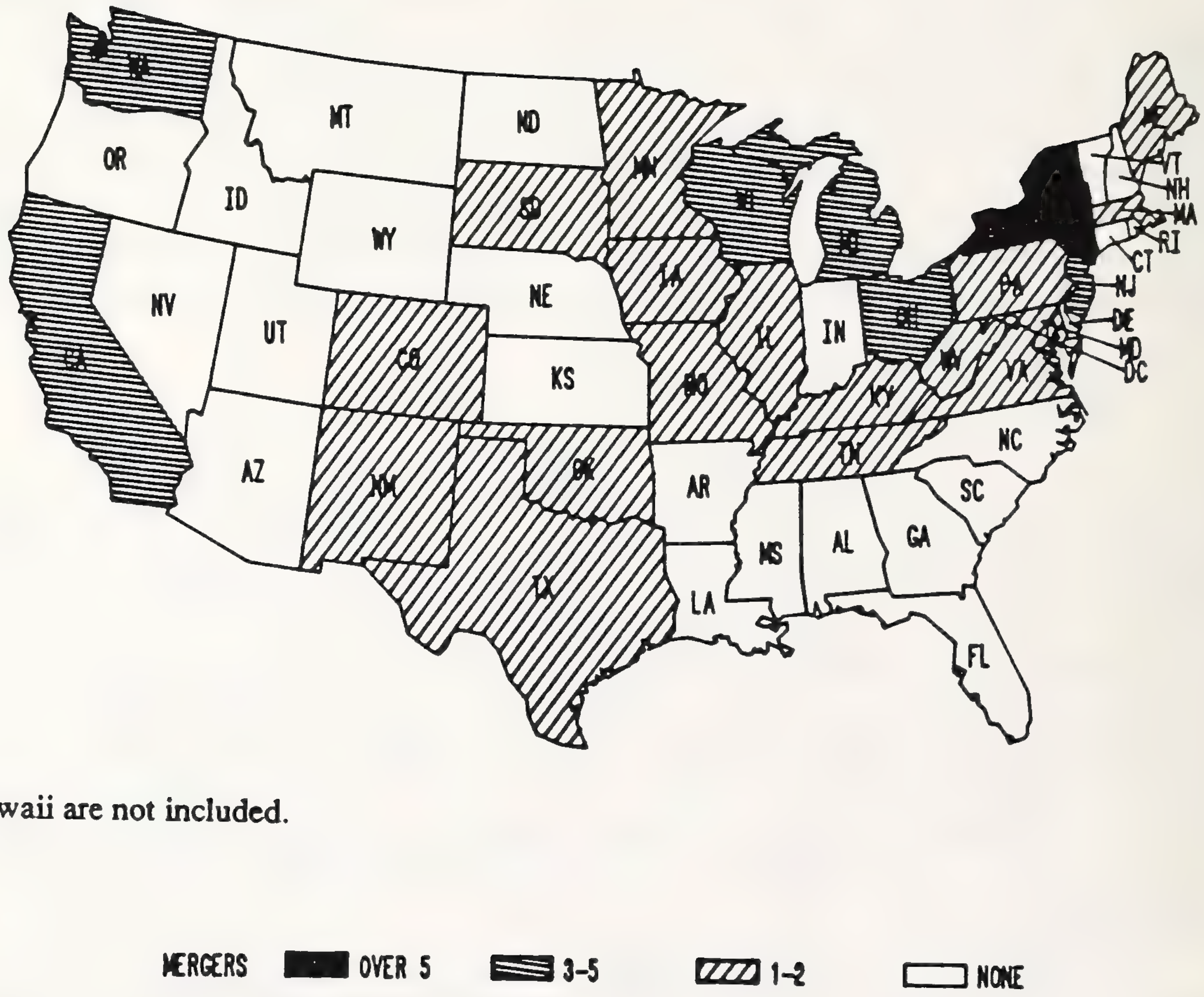
4.1 Location

The map of the United States in Figure 4-1 shows the number of mergers by state (excluding Alaska and Hawaii). Half of the states had no mergers during the first half of the 1980s. New York had the greatest number, with over 5 mergers. This may be due to the large number of hospitals in New York City, which has a higher concentration of hospitals than any other city in the nation, except for Los Angeles. Therefore there may be more hospitals with the potential to merge. Also New York is a heavily regulated state and this may encourage hospitals to merge. Four of the six states with 3 to 5 mergers during this time are east of the Mississippi. The other two are on the Pacific Coast. States where 1 or 2 mergers occurred were spread evenly across the country.

Inspection of Figure 4-1 suggests no single explanation for the occurrence of mergers. They occurred in states with both hospital closures and openings, growing and declining state populations, and strong and weak state economies. States with no mergers are primarily sparsely populated.

FIGURE 4-1

DISTRIBUTION OF MERGERS BY STATE 1980-1986*



*Alaska and Hawaii are not included.

For example, in the Northeast the states that lacked merger activity (Vermont, New Hampshire, Rhode Island, and Connecticut) are small states with few hospitals. In many states, the scarcity of hospitals may account for the absence of merger activity. When hospitals are farther apart there may be little to gain from combining operations.

Table 4-1 lists urban and rural mergers in non-waivered states by region, by pre- and post-PPS. Of the 40 mergers, almost 60% (23) were in urban areas. The majority of these occurred in the East North Central, Pacific, and West North Central Census divisions, with almost twice as many mergers occurring in the East North Central region as in any other region in the country, due to Michigan, Ohio, and Wisconsin.

In addition to large numbers of urban mergers, the numbers of rural mergers were also relatively high in the East North Central states (4). The Mountain division of the West had three rural hospital groups merge in the early 1980s but had no urban mergers. This reflects the relatively rural nature of the populations in these states compared to states such as Michigan, which contain some of the largest cities in the country.

More mergers might be expected during the first four years compared to the last two in the analytic period, just because there was more time. Yet almost twice as many urban mergers in non-waivered states occurred post-PPS than pre-PPS. Because of the differing length of the pre-PPS and post-PPS time periods, annual mergers post-PPS are almost four times greater than the annual average pre-PPS. The only region that had more urban mergers occur pre-PPS than post-PPS was the East South Central region. One could argue that the sizable increase of urban merger activity during the prospective payment period could be linked to changes in reimbursement policies. Merging may be a way for hospitals to increase operating efficiency and maintain financial viability.

In the waivered states (Massachusetts, New York, New Jersey, and Maryland), all of the merger activity occurred in urban areas. This can be explained by the predominance of urban mergers in the heavily urbanized states (New York, New Jersey and Massachusetts). In the Northeast and the Middle Atlantic, roughly an equal number of mergers occurred pre- and post-PPS. Only in Maryland, in the South Atlantic region, did more mergers occur post-PPS than pre-PPS (none occurred pre-PPS).

4.2 Size

Urban mergers in non-waivered states tended to involve one large and one much smaller hospital with the result being a very large hospital. Table 4-2 shows that 57 percent of the hospitals that merged had fewer than 200 beds but only 17 percent of the 23 resulting hospitals were this small. Conversely, 61

TABLE 4-1

MERGERS BY REGION PRE/POST PPS*

	NON-WAIVERED STATES		WAIVERED STATES	
	Number of Mergers		Number of Mergers	
	Pre-PPS	Post-PPS	Pre-PPS	Post-PPS
Northeast				
Urban	0	0	1	1
Rural	1	1	0	0
Middle Atlantic				
Urban	0	0	6	5
Rural	1	1	0	0
South Atlantic				
Urban	0	1	0	1
Rural	0	1	0	0
East North Central				
Urban	3	7	0	0
Rural	2	2	0	0
East South Central				
Urban	1	0	0	0
Rural	1	0	0	0
West North Central				
Urban	2	2	0	0
Rural	1	1	0	0
West South Central				
Urban	1	0	0	0
Rural	1	1	0	0
Mountain				
Urban	0	0	0	0
Rural	2	1	0	0
Pacific				
Urban	1	5	0	0
Rural	0	0	0	0
TOTAL				
Urban	8	15	7	7
Rural	9	8	0	0

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR297/81088

TABLE 4-2

URBAN AND RURAL MERGERS BY BEDSIZE, NON-WAIVERED STATES, 1980 - 1986*

	NON-WAIVERED STATES				WAIVERED STATES	
	URBAN N = 23		RURAL N = 17		URBAN[a] N = 14	
Hospital Bedsize	Merging Hospitals[b]	Merger Results	Merging Hospitals[c]	Merger Results	Merging Hospitals[d]	Merger Results
6 - 99	27.8%	4.3%	44.1%	17.6%	7.7%	0.0%
100 - 199	29.6	13.0	47.1	35.3	30.8	7.1
200 - 299	14.8	8.7	2.9	35.3	26.9	0.0
300 - 399	7.4	4.3	2.9	5.9	19.2	35.7
400 - 499	13.0	8.7	---	---	3.8	7.1
500+	7.4	60.9	2.9	5.9	11.5	50.0
TOTAL[e]	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*Excluding Alaska and Hawaii.

[a] There are no rural mergers in waivered states.
[b] 47 hospitals are involved in urban mergers in non-waivered states.
[c] 34 hospitals are involved in rural mergers in non-waivered states.
[d] 29 hospitals are involved in urban mergers in waivered states.
[e] May not add to 100 due to rounding error.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR297/81088

percent of the urban merger results had over 500 beds. Inspection of the merges shows that most occurred between one hospital with over 200 beds and one much smaller. In one case, three small hospitals merged.

The 17 rural mergers in non-waivered states were almost all between hospitals under 200 beds and the results were primarily (70.6 percent) hospitals with bedsizes of 100-300. Only two rural mergers involved hospitals with more than 300 beds and these facilities merely merged with a small neighbor with fewer than 100 beds.

These different patterns reflect the distribution of hospitals in urban versus rural areas. Our definition of mergers included only those that involved hospitals in the same or neighboring counties. Rural counties usually do not contain many hospitals and those with the population to sustain a really large facility rarely have a second nearby. The rural pattern therefore indicates two small hospitals in the same county joining together to form a larger facility. In urban areas, with greater numbers of hospitals in the same county, it appears that large hospitals acquired smaller neighbors.

As previously mentioned all of the merger activity in the waivered states occurred within urban areas. Like the urban merger activity in the non-waivered states, most of the merger result hospitals (50%) had over 500 beds. Further, only one (7 percent) of the results of a merger had fewer than 300 beds, although 65.4 percent of the hospitals that merged were in those bedsize categories. In the waivered states, then, medium-sized urban hospitals merged to become very large institutions.

Closures decrease the number of beds in hospital markets as a whole. Table 4-3 shows that mergers also decreased industry capacity although in a few instances, the merger results were larger than the sum of the beds in the merging hospitals. The first column gives the mean number of beds for the groups of hospital that merged. The second indicates by how much the result of the merger was larger (+) or smaller (-). For example, for mergers in the smallest bedsize category, the average total number of beds in the hospitals pre-merger was 72 and the resulting facility was 11 percent (8 beds) larger than that. Only the 300-399-bed category also saw an expansion of bed capacity (by less than one percent, however). The others shrank by four to 33 percent with the average change in the bedsize of the system a 7.3 percent decrease.

The greatest loss of urban beds occurred for hospitals with either 200 to 299 or 400 to 499 beds involved initially. The former mergers saw a decrease of almost one fifth of the pre-merger beds. The latter group shrank even more. The average decrease was a third. This contrasts with the rural mergers in which very few staffed beds were closed. The smallest bedsize category shrank an average of 22 percent from 76 beds in total before the merger to only 59. This was an exception, however. Larger merging groups

TABLE 4-3

BEDSIZE OF URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITALS THAT MERGE AND THE AVERAGE INCREASE OR DECREASE IN BEDS, NON-WAIVERED STATES, 1980 - 1986*

	URBAN	
Bedsize Category	Mean Total Beds - Merging Hospital Groups	Average Bedsize Change in Merger Result Hospitals
6 - 99	72	+11.1%
100 - 199	167	-4.2
200 - 299	239	-18.2
300 - 399	380	+.6
400 - 499	455	-33.2
500+	645	-3.9
TOTAL	507	-7.3

	RURAL	
Bedsize Category	Mean Total Beds - Merging Hospital Groups	Average Bedsize Change in Merger Result Hospitals
6 - 99	76	-22.1%
100 - 199	156	-1.4
200 - 299	243	-5.0
300 - 399	331	-5.3
400 - 499	---	---
500+	659	0
TOTAL	223	-6.7%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR2970/81088

changed size not at all (the over 500 bed group) or only one to five percent. Overall rural mergers in non-waivered states accounted for an average 6.7% decrease in beds between the merging hospital groups and the merger result hospitals.

When one compares, in Table 4-4, the number of urban hospitals involved in mergers in non-waivered states with the total hospitals in 1980, it is clear that urban mergers did not affect a significant portion of all 1980 hospitals. Only 1.8 percent of the 1980 hospitals within urban areas in non-waivered states were involved in mergers during the period 1980-1986 and these hospitals contained only 1.9 percent of the total 1980 beds. Further, the net change in the number of staffed beds was only 872, a decrease in capacity of only 0.1 percent. Only for hospitals with more than 500 beds did mergers affect a large proportion, 12 percent of the hospitals and 5.7 percent of their beds.

Similarly rural mergers in non-waivered states affected only 1.3 percent of rural hospitals and only 1.9 percent of rural hospital beds (base year of 1980). Yet for the four rural hospitals with over 500 beds, mergers affected half. Overall, rural mergers in non-waivered states produced a net loss of 146 beds from the rural hospital market with no decrease in capacity in the largest rural hospitals.

4.3 Ownership

Urban markets are dominated by non-government, not-for-profit institutions (see Table 4-4) which comprise over 1,600 facilities compared to only 500 investor-owned, for-profits and 467 local government-owned hospitals. The rural acute-care industry, by contrast, is as dependent on government facilities as it is on private voluntary ones: 1,271 and 1,183, respectively in 1980. Rural proprietary hospitals numbered only 226 in 1980, less than ten percent of all rural facilities.

Merger activity in both urban and rural areas occurred almost always between private, not-for-profit hospitals, however (see Table 4-5). Ninety-one percent of urban mergers and 82 percent of rural ones were between hospitals in this ownership category. In urban areas, only one local government and one for-profit merger occurred. Only three rural mergers were between local government hospitals. In waivered states, all mergers were among not-for-profit facilities.

Table 4-6 compares the ownership status of merging hospitals with all hospitals in 1980. The most important point here is that merger activity, even among private voluntary hospitals, affected a very small part of the industry. Only 1.8 percent of all urban hospitals and 1.3 percent of rural

TABLE 4-4

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL MERGERS AND RESULTING BED REDUCTIONS BY BEDSIZE, NON-WAIVERED STATES, 1980 - 1986*

URBAN MERGERS

Number of Beds per Merger	Total 1980 Hospitals	Total 1980 Beds	Total Beds of Merging Hospitals	Percent of 1980 Beds Involved In Mergers	Change in Beds Following Merger
6 - 99	708	41,529	72	0.17%	+8
100 - 199	678	97,852	167	0.17	-7
200 - 299	462	112,098	718	0.64	-129
300 - 399	299	101,712	760	0.75	+8
400 - 499	219	97,128	910	0.94	-303
500+	235	159,091	9,034	5.68	-449
TOTAL	2,601	609,410	11,661	1.91	-872

RURAL MERGERS

Number of Beds per Merger	Total 1980 Hospitals	Total 1980 Beds	Total Beds of Merging Hospitals	Percent of 1980 Beds Involved In Mergers	Change in Beds Following Merger
6 - 99	2,099	99,433	228	0.23%	-43
100 - 199	449	61,240	781	1.27	-10
200 - 299	100	23,760	1,460	6.14	-58
300 - 399	22	7,109	662	9.13	-35
400 - 499	8	3,373	0	---	0
500+	4	2,363	659	27.89	0
TOTAL	2,682	197,278	3,790	1.92	-146

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR297/81088; KLR510/82988; KLR463/82588

TABLE 4-5

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL MERGERS BY OWNERSHIP, NON-WAIVERED STATES, 1980 - 1986*

Hospital Ownership Of Merger Result Hospitals	NON-WAIVERED		WAIVERED
	Urban Mergers	Rural Mergers	Urban[b]
Government, Non-federal	4.3%	17.6%	---
Non-Government, Not for Profit	91.3%	82.4%	100.0%
Investor-owned, For Profit	4.3%	---	---
TOTAL[a]	100.0%	100.0%	100.0%

*Excluding Alaska and Hawaii.

[a] May not add to 100 due to rounding error.
[b] In the waivered states mergers only occurred in urban areas.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR297/81088

TABLE 4-6

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL MERGERS BY OWNERSHIP COMPARED WITH 1980 HOSPITAL MARKET, NON-WAIVERED STATES, 1980 - 1986*

URBAN MERGERS

Hospital Ownership	Total 1980 Hospitals	Total Merging Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Merging Hospitals	Percent of 1980 Beds
Government, Non-federal	467	2	.4%	101,699	632	.6%
Non-Government, Not for Profit	1,627	43	2.6	440,071	10,809	2.5
Investor-Owned, For Profit	504	2	.4	67,396	220	.3
Missing	3	0	0	244	0	0
TOTAL	2,601	47	1.8	609,410	11,661	1.9

RURAL MERGERS

Hospital Ownership	Total 1980 Hospitals	Total Merging Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Merging Hospitals	Percent of 1980 Beds
Government, Non-federal	1,271	6	.5%	77,747	851	1.1%
Non-Government, Not for Profit	1,183	28	2.4	104,062	2,939	2.8
Investor-Owned, For Profit	226	0	0	15,307	0	0
Missing	3	0	0	167	0	0
TOTAL	2,683	34	1.3	197,283	3,790	1.9

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR456/82488; KLR297/81088; KLR463/82588

ones were partners in mergers. While non-government, not-for-profit hospitals comprised 71 of the 81 non-waivered, acute-care mergers, these made up only about 2.5 percent of either the urban or the rural total for this category and a slightly larger proportion of the bed capacity.

4.4 Utilization and Market Shares

Table 4-7 depicts the average utilization of hospitals prior to their merging and after merging. It shows that the mean occupancy rates of urban and rural hospitals involved in mergers are high, over 60 percent for urbans and 55 percent for rural hospitals. The mean admissions of urban mergers are about twice as large as the mean admissions of rural mergers and the mean outpatient visits of urban mergers are more than twice as large as the mean outpatient visits of rural mergers. One might expect these results since rural areas are less populous than urban areas. Further, utilization fell after the mergers but more for outpatients than inpatients and more in rural than in urban markets.

For urban mergers, the occupancy rates for both the merging hospital groups and the merger result hospitals were high, sixty-three and sixty-five percent respectively. While the mean number of admissions declined an average of 130 from the pre-merger to the post-merger hospitals we have seen that bedsize contracted relatively more. This accounts for the increased occupancy rate. Outpatient visits declined markedly for the merging hospital groups. The mean number of outpatient visits of the merging hospital groups in urban areas were 20 percent higher than the mean outpatient visits of the merger result hospitals. Therefore about 20,000 people seemed to choose alternative outpatient facilities following the mergers.

Other interpretations are equally likely, however. For example, the mergers may have greatly reduced outpatient referrals between urban neighbors. Because so many urban mergers involved one large and one small urban hospital, it is possible that the outpatient activities were consolidated and referrals from the small to the large clinic were eliminated. The reasons for the decline cannot be determined here.

In rural areas in non-waivered states the mean occupancy and annual admissions of merging hospital groups were 8 to 10 percent higher than the means of the merger result hospitals. The mean outpatient visits of the rural merging hospital groups were also more (15 percent higher) than the mean for the merger result hospitals. The average overall utilization of merger result hospitals in rural areas therefore declined following the mergers.

What share of their market areas do mergers represent? Table 4-8 shows the average market share for both urban and rural merging hospitals both pre- and post-PPS. The market share is defined as the ratio of each merger's beds

TABLE 4-7

AVERAGE UTILIZATION OF URBAN AND RURAL SHORT-TERM, ACUTE-CARE MERGERS NON-WAIVERED STATES, 1980 - 1986*

	URBAN MERGERS			RURAL MERGERS		
	Mean Occupancy Rate	Mean Admissions	Mean Outpatient Visits	Mean Occupancy Rate	Mean Admissions	Mean Outpatient Visits
Last Year Of Merging Hospital Groups	63%	16,407	104,041	66%	8,599	44,638
First Year Of Result	65%	16,240	83,059	58%	7,911	37,106

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR684/100988

TABLE 4-8

AVERAGE MARKET SHARE OF MERGING HOSPITALS, ALL STATES, 1980 - 1986*

NON-WAIVERED STATES

	PRE - PPS		POST - PPS	
	Merger Inputs	Merger Results	Merger Inputs	Merger Results
Average Market Share				
Urban	15%	13%	12%	12%
Rural	29%	27%	20%	18%

WAIVERED STATES

	PRE - PPS		POST - PPS	
	Merger Inputs	Merger Results	Merger Inputs	Merger Results
Average Market Share				
Urban	9%	9%	4%	4%
Rural	---	---	---	---

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File. KLR656100188 to the total in its MSA (for urban hospitals) or county (for rurals). Rural hospitals have a larger market share than urban hospitals both before and after the mergers. Mergers occurring after the start of PPS have smaller market penetration in both urban and rural areas, even in the waivered states.

Before PPS, rural mergers in non-waivered states affected 29 percent of their county's acute care beds compared to only 15 percent in metropolitan areas, on average. Urban mergers in waivered states averaged only nine percent market shares but this may reflect the merger activity in New York. The hospitals resulting from the mergers in the waivered states maintained their market share while those in non-waivered states contracted two percentage point, both urban and rural. This is the same change discussed in Section 4.2 concerning the small reduction in bedsizes following mergers.

Following PPS, the hospitals merging in non-waivered states had only 12 or 20 percent of their markets (in urban and rural areas respectively). This is smaller than for pre-PPS mergers and represents a greater decrease for rural compared to urban hospitals. In states waivered from prospective payment, the size of merging hospitals relative to their markets also decreased, from 9 to only 4 percent.

4.5 Financial Status

To examine the financial health of hospitals that were involved in mergers, requires the costs and financial margins of the groups of merging hospitals and the merger result hospitals for a few years previous to their merger, and a few years after the merger. Our financial data spans only a four year period. These periods: TEFRA, PPS-1, PPS-2, PPS-3, can be different time periods for each hospital. Also, hospitals that were involved in mergers could have merged at any point during this period. Therefore, though we may have four years of financial information for hospitals that were involved in a merger during PPS-3, we may only have one year of financial information for a hospital that was involved in a merger during TEFRA. Because of these limitations, we were unable to track hospitals prior to their mergers to assess their financial health as separate facilities. Therefore we chose to compare average costs per case and the amount of costs collected for the merger result hospitals from TEFRA to PPS-3 and hospitals with no change in acute-care status during this period. The results are presented in Tables 4-9 and 4-10. As can be seen under the TEFRA column we have financial information on more than 40 merger result hospitals. Between TEFRA and PPS-2 we gain information on eight more hospitals that merged. In PPS-3, we have financial information for only 38 hospitals, however.

2194P/104P

TABLE 4-9

AVERAGE COSTS PER CASE FOR MERGING HOSPITALS, TEFRA THROUGH PPS-3*

	MEAN OPERATING COSTS PER CASE			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	$2,735	$3,120	$3,508	$4,069
Hospital Mergers Reporting for Each Year	3,278 (n=43)	4,231 (n=50)	4,694 (n=51)	5,508 (n=38)

*Excluding Alaska and Hawaii.

Source: Medicare Cost Reports; EXK456/92788; 458/92788

TABLE 4-10

PERCENT OF COSTS COLLECTED BY MERGING HOSPITALS, TEFRA THROUGH PPS-3*

	MEAN PERCENT OF OPERATING COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	99.2%	101.9%	99.5%	97.2%
Hospital Mergers Reporting for Each Year	103.0 (n=43)	99.8 (n=50)	98.3 (n=51)	95.8 (n=38)

	MEAN PERCENT OF TOTAL COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	104.0%	107.2%	105.1%	102.8%
Hospital Mergers Reporting for Each Year	108.3 (n=41)	105.5 (n=50)	103.7 (n=51)	103.5 (n=38)

*Excluding Alaska and Hawaii.

Source: Medicare Cost Reports; EXK2249188; EXK301/9888

Table 4-9 shows that hospitals resulting from mergers were more costly per case in each of the four fiscal years. These costs are not standardized for factors such as relative wages, casemix differences, teaching activities, etc. Therefore the actual cost difference associated with being a merger may be more or less than that indicated here. Did these higher costs imply greater financial difficulty?

As can be seen in the upper portion of Table 4-10, during TEFRA merger result hospitals collected more of their operating costs through operating revenue than hospitals with no change in acute-care status. Yet from PPS-1 to PPS-3 these merger result hospitals consistently collected less of their operating costs (over 1% less) through operating revenue than hospitals with no change in acute-care status. Once one adjusts for non-operating revenues and costs the picture looks almost the same except for the PPS-3 period. Hospitals that merged still consistently collected less revenues than they needed to cover their costs during the PPS-1 and the PPS-2 time periods, and for every dollar spent they collected less in revenue than the hospitals with no change in acute-care status. Yet during TEFRA and PPS-3 merger result hospitals collected more of their total costs through revenues than hospitals with no change in acute-care status.

Table 4-11 presents the proportion of both operating and total costs collected by hospitals defined by different characteristics. Mergers in the non-waivered New England and Mid-Atlantic states did the best with respect to collecting revenues. This may be a reflection of thier being of medium size, investor-owned or voluntary hospitals rather than government owned or primarily non-teaching hospitals. These latter characteristics are also associated with higher operating and total percentages.

TABLE 4-11

PERCENT OF COSTS COLLECTED BY MERGING HOSPITALS BY CHARACTERISTIC, TEFRA - PPS-3*

	PERCENT OF OPERATING COSTS COLLECTED				PERCENT OF TOTAL COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3	TEFRA	PPS-1	PPS-2	PPS-3
REGION								
New England	--	130.6%	118.0%	114.0%	--	134.3%	120.9%	111.7%
Mid-Atlantic	148.7%	140.6	104.6	100.3	153.9%	145.9	109.5	108.2
South Atlantic	87.8	83.4	90.9	60.2	102.2	99.3	99.3	77.9
East North Central	100.4	98.9	101.0	99.6	103.8	102.4	105.7	106.9
East South Central	--	--	--	--	--	--	--	--
West North Central	108.8	103.5	98.2	100.4	110.8	109.7	104.2	105.7
West South Central	90.2	82.5	79.2	90.7	101.7	91.8	91.0	108.2
Mountain	105.1	94.6	98.0	--	111.3	104.2	102.5	--
Pacific	110.8	101.8	97.9	89.3	114.4	104.8	100.5	92.4
LOCATION AND BEDSIZE								
Rural(N)								
Less than 50(2)	95.2	92.4	91.9	94.9	107.9	99.6	98.1	107.1
50-99(8)	102.4	98.0	99.3	106.5	106.6	102.5	103.9	115.6
100-169(7)	116.6	120.0	109.3	104.3	120.3	123.6	113.2	109.9
170+(1)	--	100.5	101.8	101.4	--	104.8	102.6	98.5
Urban								
Less than 100(5)	95.6	93.4	91.7	74.5	111.4	104.2	98.7	85.1
100-199(6)	103.1	96.1	93.8	88.7	103.5	99.9	97.7	91.6
200-299(4)	104.5	98.3	96.2	95.2	103.3	102.6	101.5	100.2
300-404(3)	98.1	101.1	101.5	98.8	100.8	104.1	105.3	102.2
405-504(8)	99.1	93.6	98.2	97.9	105.9	101.6	106.6	109.7
OWNERSHIP(N)								
Non-federal gov't.(4)	76.3	79.6	77.0	72.5	98.2	102.6	93.7	98.2
Voluntary(43)	105.3	102.2	100.0	99.8	109.2	106.6	104.7	105.7
Investor-owned(4)	109.1	95.4	101.1	85.7	108.2	97.5	103.4	87.8
REGULATORY DESIGNATION								
Rural Referral Center(2)	102.3	102.5	101.9	98.7	107.2	107.0	104.7	103.8
Sole Community Hospital(1)	--	85.6	87.3	--	--	95.1	94.9	--
TEACHING STATUS								
Non-teaching(27)	104.1	104.1	100.3	96.9	108.2	108.1	104.4	103.3
Minor teaching(13)	97.3	97.0	99.3	93.4	103.1	105.0	105.7	101.9
Major teaching(2)	79.4	53.6	56.4	91.0	97.8	68.7	75.6	113.7

*Excluding Alaska and Hawaii.

Source: Medicare Cost Reports. EXK461/92788

5.0 HOSPITAL OPENINGS

Policy concerns have tended to focus on the number of acute-care hospitals that are closing or merging. Another change affecting access to care is the opening of a new facility. These have received less attention. This chapter describes the 90 new acute-care hospitals that opened during the 1980s. The modal group is medium-sized, for-profit, urban hospitals with low to medium utilization and financial margins that were a little below the industry average but improving through the third year of PPS. The urban openings were concentrated in the South and West, where they tended to offset the loss of industry capacity from closures. New rural facilities occurred primarily in the Midwest, including the south central Census division, which includes the state of Texas. They did not offset rural closures.

Section 5.1 discusses the locations of acute-care openings during the 1981-1986 period. Section 5.2 presents differences in the bedsizes of urban and rural openings. Ownership of the new hospitals is the subject of 5.3, while 5.4 deals with utilization trends and market shares. Finally, section 5.5 focuses on the finances of hospitals that opened during the prospective payment analysis period (TEFRA through PPS-3).

5.1 Location

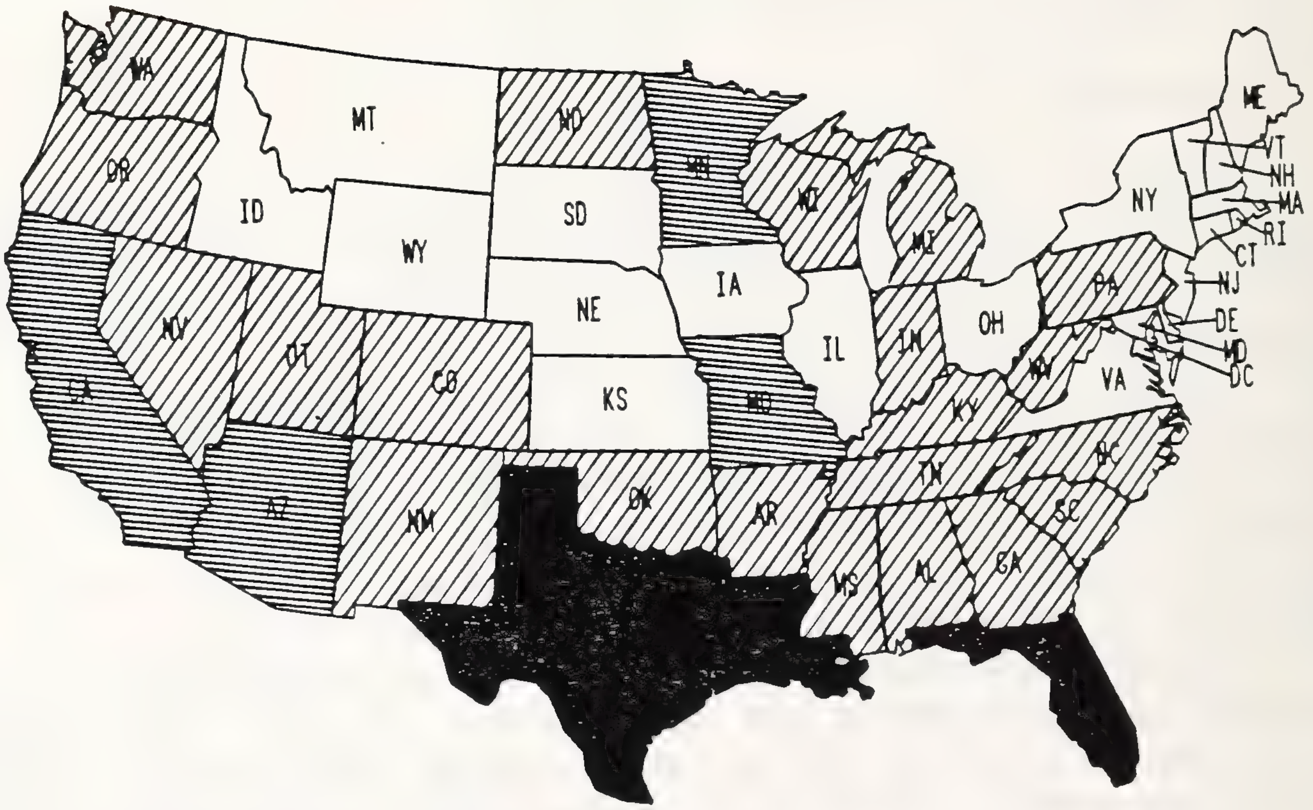
Figure 5-1 shows the distribution of openings, excluding Alaska and Hawaii. Florida, Louisiana, and Texas had the greatest numbers of openings, with over ten per state. A separate breakdown by state (not shown) lists 16 openings for Louisiana, 14 for Texas, and 11 for Florida. California was fourth with seven new hospitals. Arizona and Missouri had four each, and Minnesota had three. States with one or two openings tended to be in the South and West but a few Midwestern states also had some activity. Twenty states had no new acute-care hospitals during the 1980s. These included all of New England, the three non-New England waivered states and a large proportion of the other states north of the Mason-Dixon Line.

Table 5-1 presents the number of openings by region by year. Of the 90 openings, almost 90 percent (78) were in urban areas. They were concentrated in four Census divisions: the West South Central, South Atlantic, Mountain, and Pacific states. The number of rural mergers were also relatively high in three of the Central divisions but all nine had more urban openings than rural ones.

In six of the nine divisions, there were more acute-care openings in the four years prior to PPS than in the three years after. Only in the South Atlantic have there been markedly more openings after 1983. This post-PPS activity has been exclusively urban, however. The rapid decline in 1986 may indicate an end to the expansion of the industry but several more years of data are required before such a conclusion can be drawn.

FIGURE 5-1

DISTRIBUTION OF OPENINGS BY STATE 1980-1986*



*Alaska and Hawaii are not included.

OPENINGS ■ OVER 10 ▤ 3-10 ▨ 1-2 ☐ NONE

TABLE 5-1

OPENINGS BY REGION IN NON-WAIVERED STATES*

	1980 Number of Openings	1981 Number of Openings	1982 Number of Openings	1983 Number of Openings	1984 Number of Openings	1985 Number of Openings	1986 Number of Openings	Total Number of Openings
Northeast								
Urban	0	0	0	0	0	0	0	0
Rural	0	0	0	0	0	0	0	0
Middle Atlantic								
Urban	0	1	0	0	0	0	0	1
Rural	0	0	0	0	0	0	0	0
South Atlantic								
Urban	0	1	2	2	3	4	3	15
Rural	0	1	0	0	0	0	0	1
East North Central								
Urban	0	1	1	0	1	0	0	3
Rural	0	0	0	0	0	0	0	0
East South Central								
Urban	0	3	0	1	0	0	0	4
Rural	1	1	0	0	1	0	0	3
West North Central								
Urban	0	1	0	1	2	1	0	5
Rural	0	1	1	0	1	0	0	3
West South Central								
Urban	0	5	4	9	5	8	0	31
Rural	0	1	0	1	0	1	0	3
Mountain								
Urban	0	2	1	4	1	2	0	10
Rural	0	0	0	0	1	0	0	1
Pacific								
Urban	0	1	0	4	0	3	1	9
Rural	0	1	0	0	0	0	0	1
TOTAL								
Urban	0	15	8	21	12	18	4	78
Rural	1	5	1	1	3	1	0	12

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

5.2 Size

Urban openings between 1980 and 1986 occurred for all sizes of hospitals, from those under 24 beds to those over 200 (see Table 5-2). They were disproportionately smaller facilities, however. Eighty-seven percent were under 200 beds, although these categories accounted for only 53 percent of all urban hospitals at the start of the decade. All of the rural openings were under 200 beds, with a third of them under 25 beds. This is in marked contrast to the large proportion of closures in these same size categories for this same period of time.

Because they were generally small hospitals, urban openings accounted for a three percent increase in the number of urban hospitals but only a 1.3 percent increase in urban acute-care capacity. The rural openings, in contrast, increased rural facilities by less than half a percent and accounted for only a .2 percent increase in rural beds. Overall, we would expect these hospitals to have little impact on the industry.

5.3 Ownership

Almost two thirds (46 of 78) of the new urban acute-care hospitals were investor-owned, for-profit facilities (see Table 5-3). Only one fifth of the urban hospitals in 1980 were for profit. The disproportionate number of openings would have expanded the urban for-profit segment of the industry by nine percent had there been no closures in the same period. For-profit bed capacity expanded by about seven percent in the urban markets. This was ten times the increase in urban voluntary hospitals' capacity. While urban non-government, not-for-profit institutions accounted for 35 percent of new urban hospitals, there was a growth of only 1.7 percent of the total number and less than one percent of the total bed capacity accounted for by this type of hospital.

The twelve rural openings were also disproportionately likely to be for-profit hospitals. Twenty-seven percent of the openings but only eight percent of the hospitals in 1980 were in this group. The openings represented an expansion of only 1.3 percent in the number of for-profit facilities and one percent of the bed capacity in this segment of the industry. Overall, the expansion of the rural hospital industry was less than 0.5 percent in either the number of hospitals or beds.

5.4 Utilization

Table 5-4 presents the average utilization of the hospitals opening in the 1980s for their first year of operation. Almost half of the new urban

TABLE 5-2

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL OPENINGS AND RESULTING BED INCREASES BY BEDSIZE, NON-WAIVERED STATES, 1980 - 1986[a]*

URBAN OPENINGS

Bedsize in 1980	Total 1980 Hospitals	Percent of Total	Total Opening Hospitals	Percent of Opening Hospitals	Total 1980 Beds	Total Beds of Opening Hospitals	Percent of 1980 Beds
6 - 24	54	2.1%	5	6.4%	961	80	8.3%
25 - 49	212	8.2	15	19.2	8,185	560	6.8
50 - 99	442	17.0	20	25.6	32,383	1,456	4.5
100 - 199	678	26.1	28	35.9	97,852	3,451	3.5
200+	1,215	46.7	10	12.8	470,029	2,462	.5
TOTAL	2,601	100.0	78	100.0	609,410	8,009	1.3

RURAL OPENINGS

Bedsize in 1980	Total 1980 Hospitals	Percent of Total	Total Opening Hospitals	Percent of Opening Hospitals	Total 1980 Beds	Total Beds of Opening Hospitals	Percent of 1980 Beds
6 - 24	302	11.3%	4	33.3%	5,564	79	1.4%
25 - 49	910	33.9	5	41.7	32,248	172	.5
50 - 99	887	33.1	2	16.7	61,621	108	.2
100 - 199	449	16.7	1	8.3	61,240	100	.2
200+	134	5.0	0	---	36,605	0	---
TOTAL	2,683[b]	100.0	12	100.0	197,278	459	.2

[a] No openings occurred in waivered states during this period.

[b] Missing data for one hospital that is included in totals.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File, KLR45882488.

*Excluding Alaska and Hawaii.

TABLE 5-3

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL OPENINGS COMPARED WITH 1980 HOSPITAL MARKET BY HOSPITAL OWNERSHIP, NON-WAIVERED STATES, 1980 - 1986*

	URBAN OPENINGS					
Ownership	Percent of 1980 Hospitals	Percent of Opening Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Opening Hospitals	Percent of 1980 Beds
Government, Non-federal	18.0%	3.9%	0.6%	101,699	237	0.2%
Non-Government, Not for Profit	62.6	35.5	1.7	440,071	2,931	0.7
Investor-Owned, For Profit	19.4	60.5	9.1	67,396	4,612	6.8
TOTAL	100.0	100.0	3.0	609,410	8,009	1.3

	RURAL OPENINGS					
Ownership	Percent of 1980 Hospitals	Percent of Opening Hospitals	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds of Opening Hospitals	Percent of 1980 Beds
Government, Non-federal	47.4	27.3	0.2%	77,747	153	0.2%
Non-Government, Not for Profit	44.1	45.5	0.4	104,062	132	0.1
Investor-Owned, For Profit	8.4	27.3	1.3	15,307	158	1.0
TOTAL	100.0	100.0	0.4	197,283	459	0.2

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*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File, KLR449/82488

TABLE 5-4

AVERAGE UTILIZATION OF URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITALS AT TIME OF OPENING, NON-WAIVERED STATES, 1980-1986*

	URBAN OPENINGS				
Occupancy Rate Year Of Closure	Percent Of Urban Openings	Mean Annual Admissions	Mean Percent of Total Admissions	Mean Annual Outpatient Visits	Mean Percent of MSA Total
Low (x ≤. 3)	48%	793	.97%	5,795	1.67%
Medium (.3< x<.6)	29%	2,029	1.08%	8,954	.91%
High (x ≥ .6)	23%	6,427	3.30%	38,117	6.82%
TOTAL	100%	2,424	1.53%	32,585	2.61%

	RURAL OPENINGS				
Occupancy Rate Year Of Closure	Percent Of Rural Openings	Mean Annual Admissions	Mean Percent of Total County Admissions	Mean Annual Outpatient Visits	Mean Percent Of County Total
Low (x ≤. 3)	25%	1,037	100.00%	2,393	100.00%
Medium (.3< x<.6)	25%	779	16.64%	4,118	26.09%
High (x ≥ .6)	50%	1,692	60.92%	5,901	56.48%
TOTAL	100%	1,300	59.62%	4,578	59.76%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File, KLR557/83188, KLR642/9888.

hospitals had low occupancy (30 percent or less of their beds were filled). More than another quarter had only medium utilization of 30 to 60 percent of capacity. These two groups of new hospitals also had low outpatient utilization and penetrated only a one to two percent market share.

The quarter of the new hospitals with high occupancy had higher numbers of inpatients but even larger proportions of their outpatient markets. Here, in their first years of operation they had attained a seven percent market share with an average of 120,000 annual outpatient visits.

Rural utilization was much lower. Even the high occupancy rural openings had fewer than 2,000 inpatients in their first years of operating and no more than 6,000 outpatients. Nevertheless, these patients represented large shares of these rural county markets. For three quarters, the new hospital had more than half of both the inpatient and outpatient markets in its first year. The remaining quarter had only a sixth of the county inpatients and a quarter of the outpatients, still far greater than in urban areas. Perhaps the greater competition accounted for the lower utilization.

5.5 Financial Status

New hospitals were more costly, on average, in each of their fiscal years than hositals that did not change status during the 1980s (See Table 5-5). These costs are unadjusted for relative wages, casemix, or other factors. Because the majority of openings were in urban areas the higher costs may be due to higher input prices. However, opening hospitals were below the average in size, therefore one would expect them to have somewhat lower costs. Future research may indicate large overhead for new, relatively under-utilized facilities with high promotional costs as well.

Table 5-6 summarizes the percent of operating and total costs collected by hospitals that opened prior to the third year of PPS. The number of hospitals for which financial information was available grew each year because the number of opening hospitals increased. Each year includes both hospitals in their first year of operation and those that opened earlier in the decade which are therefore more established in their operations.

In general, their performance was below that for the industry as a whole but improved over the years from TEFRA through PPS-3. For example, patient revenues in TEFRA were only 92.9 percent of operating costs for hospitals that opened sometime during the 1980s. This was about six percent lower than the 99 percent collection rate for the comparison group (hospitals with no change in their acute-care status, i.e., that did not open, close, merge, etc.). In the first year of PPS both groups did better but opening hospitals were still in the red trying to cover operating expenses. However, the gap with the comparison group narrowed slightly.

TABLE 5-5

AVERAGE COSTS PER CASE FOR OPENING HOSPITALS, TEFRA THROUGH PPS-3*

	MEAN PERCENT OF OPERATING COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	$2,735	$3,120	$3,508	$4,169
Hospital Openings Reporting for Each Year	3,932 (n=29)	3,844 (n=49)	4,524 (n=56)	4,967 (n=44)

*Excluding Alaska and Hawaii.

Source: Medicare Cost Reports EXK456/92788; EXK458/92788.

TABLE 5-6

PERCENT OF COSTS COLLECTED BY OPENING HOSPITALS, TEFRA THROUGH PPS-3*

	MEAN PERCENT OF OPERATING COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	99.2%	101.9%	99.5%	97.2%
Hospital Openings Reporting for Each Year	92.9 (n=29)	96.2 (n=49)	95.2 (n=56)	99.4 (n=44)

	MEAN PERCENT OF TOTAL COSTS COLLECTED			
	TEFRA	PPS-1	PPS-2	PPS-3
Hospitals with No Change in Acute-Care Status	104.0%	107.2%	105.1%	102.8%
Hospital Openings Reporting for Each Year	94.2 (n=29)	99.4 (n=49)	97.0 (n=56)	100.8 (n=44)

*Excluding Alaska and Hawaii.

Source: Medicare Cost Reports
EXK224/9188, EXK301/9888

It narrowed more in the second year of PPS, when both groups collected slightly less of their operating costs as patient revenues. In PPS-3, however, new hospitals did better than the comparison group. They collected over 99 percent of their operating costs, compared to only 97 percent for hospitals with no change in status.

With respect to collecting total costs, opening hospitals did worse than others. In TEFRA, for example, they collected only 94 percent of total costs compared to 104 percent for other hospitals. This gap is markedly narrower only in PPS-3, when it closed to 100.8 versus 102.8 percent. Some of the gap is undoubtedly due to the non-profit status of many of the new hospitals. Investor-owned hospitals receive no tax subsidies and fewer contributions than do government-operated or voluntary hospitals. In addition, given their low total margins, the opening hospitals cannot have accumulated financial reserves either to provide investment income or to subsidize later years.

TABLE 5-7

PERCENT OF COSTS COLLECTED BY OPENING HOSPITALS BY CHARACTERISTIC TEFRA - PPS-3

	Percent of Operating Costs Collected				Percent of Total Costs Collected			
	TEFRA	PPS-1	PPS-2	PPS-3	TEFRA	PPS-1	PPS-2	PPS-3
Region								
New England	--	--	--	--	--	--	--	--
Mid-Atlantic	97.1%	98.6%	97.4%	99.1%	103.1%	90.8%	105.2%	100.5%
South Atlantic	110.2	116.5	102.4	103.2	107.7	110.0	99.2	100.9
ENC	88.6	86.9	100.3	101.8	94.7	91.5	104.0	108.3
ESC	105.3	74.9	100.0	96.6	106.5	100.0	101.1	98.3
WNC	78.4	92.3	93.5	90.3	80.8	96.4	96.8	93.7
WSC	89.1	98.2	91.6	99.1	91.0	100.1	93.8	100.4
Mountain	91.6	88.9	99.8	100.7	90.5	94.2	103.2	104.2
Pacific	97.1	95.1	87.9	90.2	97.4	95.9	88.7	91.4
Location and Bedsize								
Rural								
Less than 50	99.3	99.2	98.9	89.8	99.6	101.2	100.3	91.8
50-99	88.2	103.3	94.4	95.8	92.0	107.1	98.0	98.8
Urban								
Less than 100	90.2	86.6	84.4	97.7	90.0	95.2	86.3	98.9
100-199	94.4	98.2	101.4	101.4	96.2	99.3	102.5	102.5
200-299	94.1	103.3	101.3	101.9	94.5	101.9	105.0	104.2
Ownership								
Non-Federal Government	94.5	81.3	96.3	104.9	98.7	104.8	100.4	108.8
Voluntary	91.7	88.7	87.0	92.6	94.9	91.9	91.5	95.9
Investor-Owned	92.9	101.0	98.1	101.7	93.4	101.1	98.6	102.0
Teaching Status								
Non-Teaching	93.4	96.8	96.3	102.0	94.4	100.6	98.3	103.4
Major Teaching	88.6	92.4	105.1	101.8	94.7	98.8	111.6	108.3

*Excluding Alaska and Hawaii.

Source: Medicae Cost Reports, EXK461/92788.

6.0 HOSPITALS CHANGING TO AND FROM ACUTE-CARE STATUS

This chapter briefly summarizes information about hospitals that changed from being specialty hospitals, as reported to the AHA, to being acute-care providers and those that switched from acute care to specialty status. There were only 32 such hospitals all together in the 1980s and not much information is available for them (for example, no financial data). However, prospective payment may have affected the rate at which hospitals changed, therefore this chapter completes the picture of acute-care hospitals that changed during the 1980s.

Table 6-1 reveals that the number of hospitals in non-waivered states changing to the provision of acute care dropped from 5 to 1 with the start of PPS. The annual number of changes from acute care to specialty status (which would exempt the hospital from prospective payment) stayed the same, however. The 15 pre-PPS changes occurred over a four-year period (almost four a year) while the 11 post-PPS switches were spread over only three years (3.67 a year). The Midwest, South Atlantic and Pacific regions contained all of this activity, both before and after PPS.

Table 6-2 underscores the fact that hospitals changing from acute care are a minuscule part of the industry. They tend to be small urban hospitals and therefore account for the loss of only 0.3 percent of the national acute-care capacity. The few hospitals that became acute-care providers did not offset this loss. They were even fewer in number and also tended to be small.

Table 6-3 summarizes changes by ownership category. As we have seen for urban openings and closings, hospitals changing their acute-care status were disproportionately for-profit. This was particularly true for those changing to exempt status. Almost half of these were for-profit compared to only about a quarter of all urban hospitals.

Table 6-4 reveals that hospitals changing from acute-care status had medium to high occupancy rates for their last year as acute-care facilities. Half had occupancies about 60 percent, for example. They also reported very active outpatient departments. Therefore, they represented two to three percent of their MSAs' markets, on average. However, whether these high occupancy rates were due to an already increased load of non-acute-care patients cannot be determined with the available data, although it is possible.

Table 6-5 shows that these hospitals were a greater part of their markets after the start of PPS compared to the pre-PPS period. This was more pronounced in the non-waivered states and for hospitals changing to acute-care status compared to those changing from it.

TABLE 6-1

CHANGES IN SERVICE BY REGION IN NON-WAIVERED STATES, 1981-1986*

	PRE-PPS		POST-PPS	
	Changes to Acute-Care	Changes From Acute-Care	Changes to Acute-Care	Changes From Acute-Care
Northeast				
Urban	0	0	0	0
Rural	0	0	0	0
Middle Atlantic				
Urban	0	0	0	0
Rural	0	0	0	0
South Atlantic				
Urban	1	2	0	2
Rural	0	0	0	0
East North Central				
Urban	0	1	0	0
Rural	0	0	0	0
East South Central				
Urban	2	2	1	1
Rural	0	0	0	0
West North Central				
Urban	0	3	0	1
Rural	1	0	0	0
West South Central				
Urban	0	3	0	3
Rural	0	0	0	0
Mountain				
Urban	0	0	0	0
Rural	0	0	0	0
Pacific				
Urban	1	4	0	4
Rural	0	0	0	0
TOTAL				
Urban	4	15	1	11
Rural	1	0	0	0

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR629 100788

TABLE 6-2

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL CHANGES IN SERVICE AND RESULTING BED CHANGES BY BEDSIZE, NON-WAIVERED STATES, 1980 - 1986*

URBAN CHANGES IN SERVICE

Bedsize in 1980	Total 1980 Hospitals	Total Changes to Acute Care	Percent of 1980 Hospitals	Total Changes From Acute Care	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds Changing to Acute Care	Percent of 1980 Beds	Total Beds Changing From Acute Care	Percent of 1980 Beds
6 - 24	54	0	0.0%	2	3.7%	961	0	0.0%	-32	-3.3%
25 - 49	212	1	0.5	6	2.8	8,185	+45	+0.5	-210	-2.6
50 - 99	442	3	0.7	11	2.5	32,383	+186	+0.6	-808	-2.5
100 - 199	678	1	0.1	7	1.0	97,852	+150	+0.1	-1,033	-1.1
200+	1,215	0	0.0	0	0.0	470,029	0	0.0	0	0.0
TOTAL	2,601	5	0.2	26	0.1	609,410	+381	+0.1	-2,083	-0.3

RURAL CHANGES IN SERVICE

Bedsize in 1980	Total 1980 Hospitals	Total Changes to Acute Care	Percent of 1980 Hospitals	Total Changes From Acute Care	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds Changing to Acute Care	Percent of 1980 Beds	Total Beds Changing From Acute Care	Percent of 1980 Beds
6 - 24	302	0	0.0%	0	0.0%	5,564	0	0.0%	0	0.0%
25 - 49	910	1	0.1	0	0.0	32,248	+35	0.1	0	0.0
50 - 99	887	0	0.0	0	0.0	61,621	0	0.0	0	0.0
100 - 199	449	0	0.0	0	0.0	61,240	0	0.0	0	0.0
200+	134	0	0.0	0	0.0	36,605	0	0.0	0	0.0
TOTAL	2,682	1	0.0	0	0.0	197,278	+35	0.0	0	0.0

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR458 82488

TABLE 6-3

URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITAL CHANGES IN SERVICE COMPARED WITH 1980 HOSPITAL MARKET BY HOSPITAL OWNERSHIP, NON-WAIVERED STATES, 1980 - 1986*

URBAN CHANGES IN SERVICE

Bedsize in 1980	Total 1980 Hospitals	Total Changes to Acute Care	Percent of 1980 Hospitals	Total Changes From Acute Care	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds Changing to Acute Care	Total Percent of 1980 Hospitals	Total Beds Changing From Acute Care	Percent of 1980 Beds
Government, Non-federal	467	1	0.2%	2	0.4%	101,699	+67	+0.1%	-262	-2.6%
Non-Government, Not for Profit	1,627	2	0.1	12	0.7	440,071	+99	0.0	-868	-0.2
Investor-Owned, For Profit	504	2	0.4	12	2.4	67,396	+215	+0.3	-953	-1.4
Missing	3	0	0.0	0	0.0	244	0	0.0	0	0.0
TOTAL	2,601	5	0.2	26	0.1	609,410	+381	+0.1	-2,083	-0.3

RURAL CHANGES IN SERVICE

Bedsize in 1980	Total 1980 Hospitals	Total Changes to Acute Care	Percent of 1980 Hospitals	Total Changes From Acute Care	Percent of 1980 Hospitals	Total 1980 Beds	Total Beds Changing to Acute Care	Total Percent of 1980 Hospitals	Total Beds Changing From Acute Care	Percent of 1980 Beds
Government, Non-federal	1,271	1	0.1%	0	0.0%	77,747	+35	0.0%	0	0.0%
Non-Government, Not for Profit	1,183	0	0.0	0	0.0	104,062	0	0.0	0	0.0
Investor-Owned, For Profit	226	0	0.0	0	0.0	15,307	0	0.0	0	0.0
Missing	3	0	0.0	0	0.0	167	0	0.0	0	0.0
TOTAL	2,683	1	0.0	0	0.0	197,283	+35	0.0	0	0.0

*Excluding Alaska and Hawaii.

Sou , Merged AHA Annual Survesy, Medicare Cost Reports, P der of Service File.
KLR629 100788

TABLE 6-4

AVERAGE UTILIZATION OF URBAN AND RURAL SHORT-TERM, ACUTE-CARE HOSPITALS AT TIME OF SERVICE CHANGE FROM ACUTE-CARE, NON-WAIVERED STATES, 1980-1986*

	URBAN CHANGES FROM ACUTE-CARE[a]				
Occupancy Rate Year Of Change From Acute-Care	N	Total Annualized Admissions	Percent of Total MSA Admissions	Total Annualized Outpatient Visits	Percent of MSA Total
Low (x ≤. 3)	2	418	.24	8,908	.95
Medium (.3< x<.6)	9	11,639	1.27	217,765	3.55
High (x ≥ .6)	12	19,853	1.90	140,818	2.39
Missing	0	---	---	---	---
TOTAL	23	31,910	1.51	367,491	2.72

*Excluding Alaska and Hawaii.

[a] There are no changes from acute care in rural areas.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR675 100988

TABLE 6-5

AVERAGE MARKET SHARE OF HOSPITALS THAT CHANGE SERVICE, ALL STATES, 1980-1985*

	NON-WAIVERED STATES			
	PRE - PPS		POST - PPS	
	Change To Acute-Care	Change From Acute-Care	Change To Acute-Care	Change From Acute-Care
Average Market Share				
Urban	3.6%	4.7%	6.9%	4.8%
Rural	100.0%	---	---	---

	WAIVERED STATES			
	PRE - PPS		POST - PPS	
	Change To Acute-Care	Change From Acute-Care	Change To Acute-Care	Change From Acute-Care
Average Market Share				
Urban	3.4%	3.4%	4.6%	4.0%
Rural	---	---	---	---

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR679 100988

REFERENCES

Hospitals, "Record Year for Closures in 1987," April 5, 1988.

Mullner, Ross, Hospital Closures, Mergers and Consolidations, Paper presented at the Third Annual Meeting of the Association for Health Services Research, June 24, 1986.

Mullner, Ross, "Rural and Urban Hospital Closures: A Comparison" Health Affairs, Fall, 1986.

Prospective Payment Assessment Commission, Medicare Prospective Payment and the American Health Care System, Report to the Congress, June 1988.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES--
DID THE PROSPECTIVE PAYMENT SYSTEM COMPRESS VARIATION IN HOSPITAL LENGTH OF STAY AND COST PER DISCHARGE?

Working Paper

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Executive Summary

The DRG payment rates of Medicare's Prospective Payment System (PPS) are fundamentally based on pre-PPS average hospital costs. For this reason, it is expected that post-PPS hospital costs and closely associated measures of utilization such as length-of-stay (LOS) will vary less than under cost-based reimbursement. Whether a compression in hospital length of stay and cost per discharge occurred in the first three years of PPS is examined in this paper. Both Medicare and total LOS and costs are analyzed. LOS is adjusted for casemix and costs are adjusted for both casemix and hospital input price inflation.

Variation in LOS and Medicare costs was less in the third year of PPS than in the Tefra year. Adjusted for casemix, the variance in Medicare LOS fell by 16.3 percent and the variance in total LOS, unadjusted for casemix, fell by 13.5 percent. Adjusted for casemix and inflation, the variance of Medicare cost per case fell by 5.6 percent over the three year period. Cost per discharge for all cases, however, was considerably more variable in PPS 3 than Tefra.

The compression was due to larger reductions or smaller increases in LOS and costs by long-LOS, high-cost hospitals, which were under greater financial pressure from PPS, than by short-LOS, low-cost hospitals, which were under less pressure. Interestingly, shorter-stay, lower-cost hospitals did not rise toward the mean in response to PPS average rates, but shortened stays and lowered real costs, although less than upper-tail hospitals. This response limited the amount of compression in the LOS and cost distributions.

Most of the compression occurred between market areas rather than within them. About three-quarters of the lower variance in casemix-adjusted Medicare LOS and all of the compression in casemix/inflation-adjusted Medicare cost per discharge is attributed to convergence among MSAs and state rural areas.

The long-term effects of PPS on variation in costs and LOS are unclear. Major reductions in LOS and real costs occurred between Tefra and the first year of PPS. After that, the LOS distribution has been stable and cost per discharge has resumed its previous upward course. Variation in both the LOS and cost distributions is increasing, and by the third year of PPS had approached the level observed in Tefra.

DID PPS COMPRESS VARIATION IN HOSPITAL LENGTH OF STAY AND COST PER DISCHARGE?

1.0 INTRODUCTION

Since the DRG rates of Medicare's Prospective Payment System (PPS) are fundamentally based on pre-PPS average hospital costs, an expected effect of PPS is a reduction in the variation among hospitals in cost per discharge and length-of-stay (LOS). Whether a compression occurred in the first three years of PPS is tested in this paper. Moreover, whether changes in variation occurred primarily among broad areas such as Census regions or within smaller areas such as Metropolitan Statistical Areas (MSAs) and state rural areas is analyzed. Since changes in Medicare reimbursement methodology may have spillover effects on non-Medicare patients, both Medicare and overall LOS and costs are considered.

The analysis is organized as follows. Section 2 establishes expectations about the effect of PPS on the distribution of hospital LOS and cost per discharge. The rest of the paper is empirical. Section 3 describes the data used in the analysis. The methodological basis for the empirical analysis is provided in Section 4. Section 5 analyzes changes in the basic characteristics of the distribution of LOS and costs between the Tefra and first three PPS years. Also in this section, changes in urban/rural and regional means of LOS and cost are examined within the context of overall changes in variation. Section 6 uses analysis of variance techniques to determine whether the change in the variance of LOS and costs occurred primarily within area (MSA, Census Division, Census region) or between areas. Section 7 concludes the analysis with a summary of the results.

2.0 EXPECTED EFFECT OF PPS ON VARIATION IN LENGTH OF STAY AND COST PER DISCHARGE

The PPS DRG payment rates are fundamentally based on pre-PPS average hospital costs. For this reason, it is expected that post-PPS hospital costs and closely associated measures of utilization such as length-of-stay will vary less than under the previous cost-based reimbursement. In particular, idiosyncratic high cost and high LOS outliers which were sheltered under cost-based payment should become money losers under PPS. Hospitals facing significant losses because of atypically high costs and long stays should be forced to converge to the mean. PRO review and standards -- for example, of premature discharge -- may also contribute to a more homogeneous style of medical care across hospitals and regions. Finally, the fixed-price nature of the prospective rates, which means any hospital can profit by eliminating unnecessary services and improving the efficiency of operations, should lead to a more uniform, efficient style of care.

Two aspects of PPS blunt the full force of its averaging and hence its incentives for convergence. First, during the transitional period, PPS rates are based partly on hospital-specific and regional amounts. Hence, during the first years of PPS hospitals are not fully exposed to the average national rates. Second, PPS contains numerous exceptions and special add-ons (e.g., the teaching and disproportionate share add-ons). Even after PPS transition, these deviations from averaging permit the existence of cost and LOS variation without financial losses.

Further, while the incentives for high-cost hospitals to converge are clear, the response to PPS of low-cost, low-LOS hospitals is not so predictable. These hospitals are financial winners under PPS and would sacrifice profits to converge towards the mean cost and LOS. For this reason, convergence of costs and LOS under PPS might be expected to result more from reductions among high-cost and LOS hospitals than increases among low-cost and LOS hospitals. On the other hand, nonprofit hospitals are legally required to reinvest profits in their operations. Low cost nonprofits may therefore respond to PPS reimbursement in excess of pre-PPS costs by increasing expenditures and services per discharge, including LOS. The net response of these hospitals, especially in the short-run, is unclear.

Competitive considerations may play a role in post-PPS convergence. Since PPS payment is on a per-discharge basis, competition for admissions should intensify. Within market areas (MSAs for urban hospitals), nonprice competition among hospitals may force each hospital to offer a similar level of services, including LOS, and hence incur similar costs. If so, a particularly strong convergence of casemix-adjusted costs and LOS in highly competitive market areas might be observed. An additional factor promoting an MSA-specific convergence in costs is the MSA-specific PPS wage index, which means that the basic PPS payment rate for a DRG is identical within MSAs, but different between them.

3.0 DATA

The data used in this paper are from the Hospital Cost Report Information System (HCRIS), which is derived from the Master File of Medicare cost reports. The analysis is limited to hospitals meeting the following criteria:

- They are located within the 50 states.
- They are "general short term" community hospitals (with average lengths of stay less than 25 days).
- They operate as voluntary, proprietary or nonfederal government institutions.
- They have cost report data for TEFRA and PPS years 1-3.

To analyze the impact of PPS, four analytic years were constructed. The "Tefra" year refers to a hospital's cost report period prior to its enrollment in PPS. The "PPS 1" year refers to a hospital's first cost report period on PPS and similarly for PPS 2 and 3. The construction of these analytic years is detailed elsewhere.

The definition of the four basic variables analyzed in the paper is relatively straightforward. Medicare LOS is total Medicare inpatient days divided by the number of Medicare discharges. Hospital-wide LOS is total hospital inpatient days divided by the total hospital discharges. Both LOS variables exclude swing beds. Medicare cost per discharge is total inpatient cost allocated to Medicare patients including passthroughs such as capital and medical education divided by the number of Medicare discharges. Hospital-wide cost per discharge is total inpatient costs, including capital, divided by the total discharges.

Medicare LOS and costs are adjusted for casemix. This is done through deflation by a LOS or cost casemix index based on national mean DRG LOS or cost weights and a hospital's mix of Medicare patients. The adjustment is based on reported casemix and so may include some "DRG creep". Because of this possible bias, unadjusted Medicare LOS and costs are also analyzed. Unfortunately, no casemix adjustment for all patients was available. Both Medicare and total costs are adjusted for inflation through deflation by the PPS hospital market basket index. Quarterly inflation figures and information on the months a hospital was on a payment system were used to standardize costs both within and across payment systems. All costs were standardized to October 1982.

Because of the focus on PPS effects, the PPS-waivered states -- New York, New Jersey, Massachusetts, and Maryland -- are excluded from the analysis. The following outlier trims were adopted: hospitals were excluded from all analyses if their Medicare or total LOS was less than one day or greater than 25 days in any analytic year, or if their total or Medicare cost per discharge was less than 500 dollars or greater than 10,000 dollars.* The final sample size is 3,018 hospitals.**

4.0 METHODS

This section provides the methodological underpinning for the empirical analysis of changes in variation. Section 4.1 discusses the choice of measure of variation to analyze distributional changes from one year to the next. Section 4.2 considers how the analysis of variance (ANOVA) technique decomposes the change in total variance into between-area and within-area components.

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*These cost trim points refer to the TEFRA year. They were inflated by the PPS market basket for other years.

**The sample is slightly smaller for analyses involving Medicare cost per case because of late-arriving data.

4.1 Choice of Measure of Variation

The degree of variation in a variable Y (e.g., LOS or cost per discharge) can be measured in various ways. The variance, standard deviation, coefficient of variation, average absolute deviation, range, and differences of the percentiles of the distribution are all measures of variation. Each has different properties. For this paper, the primary measure of variation will be the variance. The reason for this choice is that the variance is a standard, widely-used summary measure of variation which can be readily decomposed into between and within-group components as discussed in the next section. The variance of Y is defined as

$$\text{Var }(Y) = \sum_{i=1}^{n} (Y_i - Y)^2/n \tag{1}$$

where

$Y =$ mean of Y, and

$n =$ population or sample size (i.e., number of hospitals).

The variance is thus the average squared deviation of a variable around its mean.

An understanding of the properties of the variance is necessary to interpret the empirical findings. The most important properties of the variance are that it is unaffected by adding or subtracting a constant, but changes by the square of a multiplicative factor. That is,

$$\text{Var }(Y+k) = \text{Var }(Y) \tag{2}$$

but

$$\text{Var }(kY) = k^2 \text{ Var }(Y) \tag{3}$$

where k is any constant. Therefore, if the average LOS of every hospital fell by two days, the variance of length of stay would be unaffected, by equation (2). However, if the average LOS of each hospital fell by 15 percent, the variance of LOS would be only $(.85)^2 = 72.25$ percent as large as previously, by equation (3). Similarly, if the inflation rate in hospital costs between the Tefra and PPS 1 years is 5 percent, the variance in hospital costs will increase by $(1.05)^2 - 1 = 10.25$ percent due to inflation alone. In short, absolute changes in LOS or costs do not change their variance, but percentage changes do.

The coefficient of variation is often used as a measure of variation which is standardized for the mean of a distribution. The coefficient of variation is defined as the ratio of the square root of the variance (the standard deviation) to the mean:

$$CV(Y) = \sqrt{Var\ (Y)}/Y \qquad (4)$$

where

$CV(Y)$ = coefficient of variation of Y.

The useful property of CV(Y) is that, unlike the variance, it is independent of multiplicative changes in a variable:

$$CV(kY) = \sqrt{k^2\ Var(Y)}/kY = CV(Y) \qquad (5)$$

For example, if each hospital's LOS falls by 15 percent, the CV of LOS is the same. Only if the standard deviation falls proportionately more than the mean will the CV be reduced. Unfortunately, unlike the variance, the CV cannot be readily decomposed to examine between and within-group changes in variation. We use the CV as an additional measure of overall variation in LOS and costs, to indicate whether the dispersion of the distribution has tightened relative to a uniform percentage change in the variable.

4.2 Using ANOVA to Analyze Between and Within Area Changes in Variance

An issue of interest is whether changes in the variance of LOS and cost per discharge between the TEFRA and PPS years occurred mainly within areas (MSA, Census Division, or Census region) or between them. It is a remarkable property of the variance defined in equation (1) that it can be decomposed into a within-group and a between-group variance. The groups in this case are the areas. The basic analysis of variance (ANOVA) identity states that:

$$\sum_i \sum_j (Y_{ij} - Y_{..})^2 = \sum_j n_j (Y_{.j} - Y_{..})^2 + \sum_i \sum_j (Y_{ij} - Y_{.j})^2 \qquad (6)$$

where

i indexes observations (hospitals) and j areas (MSA, region, division);

$Y_{..}$ = the overall or "grand" mean;
n_j = the number of hospitals in th j^{th} area; and
$Y_{,j}$ = the mean of hospitals in the j^{th} area.

The left-hand-side sum of squares in equation (6), the numerator of the variance of Y (equation (1)), is called the total sum of squares, SS_T. The first right-hand-side sum of squares is the between-area sum of squares, SS_B. The second sum of squares on the right-hand side is the within-area sum of squares, SS_W. The ANOVA identity is that:

$$SS_T = SS_B + SS_W \tag{7}$$

Let

σ^2_{T0} = the variance of LOS or costs in the Tefra year; and

σ^2_{T1} = the variance of LOS or costs in the first PPS year.

Then, if the number of observations (hospitals) in the data set is the same in both years, the percentage change in the variance from the Tefra to the PPS year can be written

$$\frac{\sigma^2_{T0} - \sigma^2_{T1}}{\sigma^2_{T0}} = \frac{SS_{T0} - SS_{T1}}{SS_{T0}} \tag{8}$$

Using equation (7-7),

$$\frac{SS_{T0} - SS_{T1}}{SS_{T0}} = \frac{SS_{B0} + SS_{W0} - (SS_{B1} + SS_{W1})}{SS_{T0}}$$

$$= \frac{SS_{B0}}{SS_{T0}} \cdot \frac{SS_{B0} - SS_{B1}}{SS_{B0}} + \frac{SS_{W0}}{SS_{T0}} \cdot \frac{SS_{W0} - SS_{W1}}{SS_{W0}}$$

$$= R^2_0 \cdot \frac{SS_{B0} - SS_{B1}}{SS_{B0}} + (1 - R^2_0) \cdot \frac{SS_{W0} - SS_{W1}}{SS_{W0}} \tag{9}$$

where the last equality follows from the fact that the ratio of the between area sum of squares to the total sum of squares is the R-squared, or proportion of variance in LOS or costs explained by the area grouping. If the sum of squares terms in the last line of equation (9) are divided by the number of hospitals (observations), they can be interpreted as variances. When numerator and denominator are divided by n, the last line of equation (9) becomes

$$R^2_0 \cdot \frac{\sigma^2_{B0} - \sigma^2_{B1}}{\sigma^2_{B0}} + (1 - R^2_0) \cdot \frac{\sigma^2_{W0} - \sigma^2_{W1}}{\sigma^2_{W0}} \tag{10}$$

where

σ^2_{B0} = the between-area variance in the Tefra year;

σ^2_{B1} = the between-area variance in the first PPS year;

σ^2_{W0} = the within-area variance in the Tefra year; and

σ^2_{W1} = the within-area variance in the first PPS year.

Equation (6) shows that these variances are not simple variances. σ^2_{B0} and σ^2_{B1} are weighted variances of the area means around the grand mean, with the weights equal to the proportion of total hospitals in each area. σ^2_{W0} and σ^2_{W1} are weighted averages of the simple variances of hospitals around their area means, with the weights again equal to the proportion of hospitals in each area. Putting equations (8) and (10) together defines the basic decomposition utilized in Section 6:

$$\frac{\sigma^2_{T0} - \sigma^2_{T1}}{\sigma^2_{T0}} = R^2_0 \cdot \frac{\sigma^2_{B0} - \sigma^2_{B1}}{\sigma^2_{B0}} + (1 - R^2_0) \cdot \frac{\sigma^2_{W0} - \sigma^2_{W1}}{\sigma^2_{W0}} \qquad (11)$$

Equation (11) states that the percentage change in the variance of LOS or costs equals the weighted sum of percentage changes in the between-area and within-area variances. The weights are the proportion and one minus the proportion of variance in LOS or costs explained by the area grouping. Thus, a large percentage change in the between area variance might account for only a small proportion of the change in the total variance if the R-squared is small, or vice-versa.

5.0 CHANGES IN THE DISTRIBUTION OF LOS AND COST PER DISCHARGE ACROSS THE TEFRA AND PPS YEARS 1-3

This section uses simple descriptive statistics to analyze changes in the distribution of LOS and inpatient costs across the TEFRA year and first three years of PPS. Section 5.1 treats LOS and Section 5.2 treats costs.

5.1 Changes in the Variation of Length of Stay

Table 1 shows Medicare and total LOS for Tefra and PPS years 1 to 3, averaged across hospitals in our sample. Medicare LOS both unadjusted and adjusted for casemix, and unweighted and discharge-weighted series are presented. All LOS variants show a large drop between Tefra and PPS 1, a slight decline from PPS 1 to PPS 2, then stability from PPS 2 to PPS 3. Casemix adjusted Medicare LOS fell more rapidly in the first two years of PPS, and is continuing to decline slightly even from PPS 2 to PPS 3, while unadjusted Medicare LOS crept upward from PPS 2 to PPS 3. Hospitals lowered their LOS rapidly in response to PPS, then, on average, made few changes after the first year.

Table 2 shows LOS trends for urban and rural hospitals. The same trends evident for all hospitals also appear for urban and rural hospitals

TABLE 1

AVERAGE HOSPITAL LENGTH-OF-STAY BY PAYMENT PERIOD

	UNWEIGHTED			DISCHARGE-WEIGHTED		
	Medicare LOS	Medicare LOS, Casemix Adjusted	Total LOS	Medicare LOS	Medicare LOS, Casemix Adjusted	Total LOS
TEFRA	8.2	8.2	6.1	9.1	9.1	6.6
PPS-1	7.0	6.7	5.4	7.9	7.5	5.8
PPS-2	6.8	6.4	5.2	7.9	7.3	5.7
PPS-3	6.9	6.3	5.2	8.0	7.3	5.7

N = 3018

Source: Medicare Cost Reports.

TABLE 2

URBAN-RURAL AVERAGE LENGTH OF STAY, BY PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
URBAN				
Medicare LOS	9.6	8.4	8.4	8.5
Medicare LOS, Casemix-Adjusted	9.5	7.9	7.7	7.6
Total LOS	6.7	5.9	5.7	5.8
RURAL				
Medicare LOS	7.5	6.2	6.0	6.1
Medicare LOS, Casemix-Adusted	7.6	6.1	5.8	5.7
Total LOS	5.6	4.9	4.7	4.7

N = 3018

Source: Medicare Cost Reports.

separately. Unadjusted Medicare LOS fell more rapidly in the shorter-stay rural areas, producing an urban-rural divergence. Unadjusted, urban and rural Medicare LOS differed by 2.4 days in PPS 3 compared to 2.1 days in Tefra. However, adjusted for casemix, urban and rural Medicare LOS differed by an identical 1.9 days in the two payment periods. Apparently, casemix increase (or DRG creep) was greater in urban hospitals than in rural hospitals over this period.

Table 3 presents trends in LOS by region. Again, patterns similar to the overall trends are evident. LOS, both unadjusted and adjusted, fell somewhat faster in the Midwest than in other regions. In the Northeast, LOS dropped sharply in the first year of PPS, then began creeping upward. At least for Medicare cases, these increases were accounted for by a more severe reported DRG mix. There was a small reduction in the large Northeast/West difference in unadjusted LOS (for Medicare cases, from 3.0 to 2.7 days from Tefra to PPS 3). Adjusted for casemix, the reduction in this difference was somewhat greater (from 3.0 to 2.5 days).

Table 4 shows distributional statistics for Medicare LOS. As measured by the standard deviation, the variation in Medicare LOS fell considerably from Tefra to PPS 1, but then rose in PPS 2 and PPS 3. By PPS 3, the standard deviation is only 2 percent lower than in the Tefra year. The coefficient of variation rises over the period, indicating that the variation in unadjusted Medicare LOS relative to its mean was increasing. The percentiles show the entire distribution of LOS, long-stay and short-stay hospitals, shifting down by similar percentage amounts from Tefra to PPS 1. It is remarkable that short-stay hospitals were able to further reduce their LOS. In absolute terms, long stay hospitals reduced their LOS more than short stay hospitals. The 99th percentile fell by 2.2 days, the 1st percentile by 0.9 days. This produced some absolute convergence in the LOS distribution. For example, the 99th-1st percentile range in Tefra is 8.9 days, which declines to 8.2 days in PPS 3.

Table 5 shows statistics for the distribution of casemix-adjusted Medicare LOS. Casemix adjusted LOS shows a more sustained decline in variation measured by the standard deviation than does unadjusted LOS. Even in PPS 3, the standard deviation remains 8 percent lower than in Tefra. This may be mostly due to a continuing decline in mean LOS since the coefficient of variation shows the same upward trend. The upper percentiles of Medicare LOS are flat from PPS 1 to PPS 3 when adjusted for casemix, as opposed to an upward trend unadjusted. Both adjusted and unadjusted, the lower percentiles show a slight downward trend from PPS 1 to PPS 3.

Table 6 shows distributional statistics for (unadjusted) total LOS. The trends are similar to those for Medicare LOS, except somewhat less pronounced. For example, the CV rises over the period, but at a slower rate.

Table 7 presents the results of a more direct test of the effects of financial pressure due to PPS on convergence in hospital LOS. Hospitals were

TABLE 3

REGIONAL AVERAGE LENGTH OF STAY, BY PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
NORTHEAST				
Medicare LOS	9.9	8.4	8.5	8.7
Medicare LOS, Casemix Adjusted	9.7	7.9	7.9	7.9
Total LOS	7.2	6.1	6.2	6.2
MIDWEST				
Medicare LOS	8.5	7.1	6.9	6.8
Medicare LOS, Casemix Adjusted	8.5	6.8	6.4	6.3
Total LOS	6.3	5.4	5.2	5.1
SOUTH				
Medicare LOS	8.2	7.0	6.9	7.0
Medicare LOS, Casemix Adjusted	8.2	6.8	6.5	6.5
Total LOS	6.1	5.4	5.3	5.3
WEST				
Medicare LOS	6.9	5.9	5.9	6.0
Medicare LOS, Casemix Adjusted	6.7	5.5	5.4	5.4
Total LOS	5.1	4.5	4.4	4.4

N = 3018

Source: Medicare Cost Reports.

TABLE 4

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF MEDICARE LENGTH-OF-STAY BY PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	1.84	1.64	1.74	1.81
CV	22.3	23.5	25.4	26.3
PERCENTILES				
99th	13.4	11.2	11.4	11.6
95th	11.5	9.8	9.8	10.0
90th	10.7	9.2	9.1	9.3
75th	9.4	7.9	7.9	8.0
50th	8.1	6.8	6.7	6.7
25th	7.0	5.8	5.6	5.6
10th	6.1	5.0	4.8	4.7
5th	5.5	4.5	4.3	4.2
1st	4.5	3.6	3.3	3.4

N = 3018

Source: Medicare Cost Reports.

TABLE 5

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF MEDICARE LENGTH-OF-STAY, CASEMIX ADJUSTED BY PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	1.67	1.44	1.49	1.53
CV	20.3	21.6	23.3	24.0
Percentile				
99th	12.8	10.4	10.4	10.3
95th	11.2	9.2	8.9	8.9
90th	10.4	8.6	8.3	8.3
75th	9.2	7.6	7.3	7.3
50th	8.1	6.6	6.3	6.2
25th	7.1	5.7	5.4	5.3
10th	6.2	5.0	4.6	4.5
5th	5.7	4.5	4.2	4.1
1st	4.9	3.8	3.3	3.4

N = 3018

Source: Medicare Cost Reports.

TABLE 6

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF TOTAL LENGTH-OF-STAY, BY PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	1.48	1.33	1.36	1.38
CV	24.3	24.8	26.2	26.6
Percentile				
99th	10.5	9.6	9.4	9.1
95th	8.7	7.6	7.4	7.5
90th	7.9	6.9	6.8	6.9
75th	6.9	6.1	5.9	5.9
50th	5.9	5.2	5.0	5.0
25th	5.1	4.5	4.3	4.3
10th	4.5	3.9	3.7	3.7
5th	4.0	3.5	3.3	3.3
1st	3.2	2.9	2.6	2.5

N = 3018

Source: Medicare Cost Reports.

TABLE 7

AVERAGE LENGTH-OF-STAY BY EXPECTED PPS GAIN QUARTILES AND PAYMENT PERIOD

	TEFRA	PPS-1	PPS-2	PPS-3
Medicare LOS				
Gain Quartiles:				
1	9.3	7.7	7.6	7.6
2	8.6	7.2	7.1	7.1
3	8.1	6.9	6.8	6.8
4	7.2	6.2	6.1	6.1
Medicare LOS, Casemix Adjusted				
Gain Quartiles:				
1	9.1	7.2	6.9	6.9
2	8.5	6.9	6.6	6.5
3	8.1	6.6	6.3	6.3
4	7.4	6.1	5.8	5.8
Total LOS				
Gain Quartiles:				
1	6.8	5.9	5.7	5.7
2	6.2	5.4	5.2	5.2
3	5.9	5.3	5.1	5.0
4	5.5	4.9	4.8	4.7

N = 2796
1 = lowest quartile of financial gain from PPS.
4 = highest quartile of financial gain from PPS.

Source: Medicare Cost Reports.

divided into quartiles based on how much they were expected to gain financially in the short run (i.e., from Tefra to PPS 1) from the inception of PPS. Gain was calculated as the difference between expected PPS 1 payments and Tefra year costs as a proportion of Tefra costs, adjusted for the share of a hospital's business accounted for by Medicare. The hypothesis is that hospitals who gain the most from PPS will change their behavior the least, while those put under the most financial pressure will change the most. Gain quartiles are ranked from lowest gain (1) to highest gain (4).

As expected, Table 7 shows that long LOS hospitals were expected to gain the least, while short LOS hospitals were expected to gain the most. Moreover, the long LOS, low gain hospitals did reduce their LOS by the greatest number of days. For instance, the lowest gain hospitals (quartile 1) lowered their unadjusted Medicare LOS by 1.6 days, from 9.3 to 7.7 days. The highest gain hospitals (quartile 4) lowered their LOS by only 1 day, from 7.2 to 6.2 days. Some convergence due to the financial pressure of PPS appears to have occurred. However, all the convergence occurred from Tefra to PPS 1, not thereafter. Moreover, a sizeable range in LOS from low to high gain hospitals (1.5 days for unadjusted Medicare LOS) persists post-PPS.

The descriptive statistics show dramatic declines in LOS in the first PPS year, but then a relatively stable distribution in the second and third PPS years. Hospitals responded very rapidly to the incentives of PPS to reduce LOS, and were able to largely complete their adjustments in the first year. Movement towards fully national rates had little or no additional effect. Unadjusted LOS has begun slowly rising, but a more severe casemix accounts for these slight increases. Adjusted for casemix, LOS is stable or slightly falling through the third year of PPS. Long stay hospitals, which were under the most financial pressure from PPS, lowered their LOS more than short stay hospitals, producing some convergence in the LOS distribution. Rather than converging upwards towards the mean, it is remarkable that short stay hospitals were able to reduce their LOS by equal percentage amounts to long stay hospitals.

5.2 Changes in the Variation of Cost per Discharge

Tables 8 and 9 show hospital cost per discharge by payment period. In Table 9, all costs are adjusted for hospital input price inflation and standardized to October 1982. Unadjusted, Medicare cost per case (the first column of Table 8) rose by 26 percent, from 2644 dollars in the Tefra period to 3331 dollars in PPS 3. Weighted by discharges, almost the same percentage increase is observed. However, adjusted for inflation and casemix increase (the second or fifth column in Table 9), costs are actually slightly lower in PPS 3 than in Tefra. Over this three-year period, therefore, PPS was

TABLE 8

AVERAGE HOSPITAL COST PER DISCHARGE BY PAYMENT PERIOD

	UNWEIGHTED			DISCHARGE-WEIGHTED		
	Medicare Cases	Medicare Cases/ Casemix Adjusted	All Cases	Medicare Cases	Medicare Cases/ Casemix Adjusted	All Cases
TEFRA	$2644	$2603	$2418	$3191	$3149	$2789
PPS-1	2672	2508	2629	3254	3029	3006
PPS-2	2992	2713	2967	3661	3263	3349
PPS-3	3331	2977	3350	4063	3544	3712

N = 3018

Source: Medicare Cost Reports.

TABLE 9

AVERAGE HOSPITAL COST PER HOSPITAL DISCHARGE BY PAYMENT PERIOD, ADJUSTED FOR INFLATION

	UNWEIGHTED			DISCHARGE-WEIGHTED		
	Medicare Cases	Medicare Cases/ Casemix Adjusted	All Cases	Medicare Cases	Medicare Cases/ Casemix Adjusted	All Cases
TEFRA	$2500	$2462	$2286	$3017	$2978	$2638
PPS-1	2390	2243	2350	2910	2708	2688
PPS-2	2556	2317	2534	3126	2786	2860
PPS-3	2741	2449	2756	3342	2915	3053

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports.

successful in arresting the rise in real hospital costs. However, a closer inspection reveals that while real, casemix-adjusted cost (unweighted) fell by 8.9 percent from Tefra to PPS 1, it then rose by 3.3 percent from PPS 1 to PPS 2 and by 5.7 percent from PPS 2 to PPS 3 (see column 2 of Table 9). PPS thus interrupted the upward trend in costs for only one year. Unlike LOS, which remained stable after falling from Tefra to PPS 1, real costs began rising again after PPS 1.

Unlike Medicare costs, cost per discharge for all cases, even inflation-adjusted, increased from Tefra to PPS 1. It rose so much faster over the three year period that by PPS 3, unweighted cost per discharge for all cases exceeded Medicare cost per case. Discharge-weighted, Medicare costs remained higher than total costs. The weighted versus unweighted results indicate that total cost per case was rising faster relative to Medicare cost per case in smaller hospitals.

Table 10 shows costs for urban and rural hospitals for the four payment periods (all costs for Table 10 and after are inflation-adjusted). Trends similar to the overall trends are observed separately for urban and rural hospitals. Little or no convergence of urban and rural costs is evident. Cost per discharge for all cases did rise at a more rapid rate in rural than in urban hospitals.

Regional trends are shown in Table 11. Medicare cost per case shows some regional convergence. Costs in the low-cost South rose at a considerably more rapid rate than in other regions. For example, Southern costs (unadjusted) were 284 dollars below Midwestern costs in Tefra, but only 114 dollars lower in PPS 3. The South was the only region with higher casemix-adjusted costs in PPS 3 than in Tefra. The Northeast experienced the slowest inflation in total cost per case, allowing the West to surpass it by PPS 3.

Tables 12, 13, and 14 show standard deviations, coefficients of variation, and percentiles of the cost per discharge variants by payment period. Variation in Medicare cost per case--as measured by the standard deviation or CV--fell from Tefra to PPS 1, then began to rise (see Tables 12 and 13). By PPS 3, the degree of variation was not very different than in Tefra. The percentiles show that the more expensive hospitals reduced their costs more in absolute dollars from Tefra to PPS 1 than the less expensive hospitals, and costs rose more in these hospitals from PPS 1 to PPS 3. However, as was true for LOS, the entire distribution of costs shifted down; even low-cost hospitals reduced their costs from Tefra to PPS 1. By PPS 3, the range from the highest to the lowest cost hospitals (the difference of the 99th and 1st percentiles) was not very different from that in Tefra. Cost per discharge for all cases (Table 14) displays a more steady upward trend than Medicare costs, although variation relative to mean costs (the CV) is nearly constant. The range from highest to lowest cost hospitals increases over the period.

TABLE 10

URBAN-RURAL HOSPITAL COST PER DISCHARGE BY PAYMENT PERIOD (ADJUSTED FOR INFLATION)

	TEFRA	PPS-1	PPS-2	PPS-3
Urban				
Medicare Cost	$3,259	$3,087	$3,326	$3,570
Medicare Cost (Casemix-Adjusted)	3,083	2,767	2,867	3,028
Total Cost	2,820	2,881	3,071	3,319
Rural				
Medicare Cost	1,906	1,843	1,952	2,091
Medicare Cost (Casemix-Adjusted)	1,976	1,832	1,887	1,996
Total Cost	1,865	1,932	2,111	2,312

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports

TABLE 11

REGIONAL HOSPITAL COST PER HOSPITAL DISCHARGE BY PAYMENT PERIOD (ADJUSTED FOR INFLATION)

	TEFRA	PPS-1	PPS-2	PPS-3
Northeast				
Medicare Cost	$3141	$2920	$3103	$3336
Medicare Cost (Casemix-Adjusted)	2989	2674	2757	2912
Total Cost	2809	2779	2941	3182
Midwest				
Medicare Cost	2541	2433	2573	2702
Medicare Cost (Casemix-Adjusted)	2506	2277	2323	2406
Total Cost	2353	2445	2624	2840
South				
Medicare Cost	2257	2174	2348	2588
Medicare Cost (Casemix-Adjusted)	2261	2085	2177	2356
Total Cost	1999	2055	2235	2453
West				
Medicare Cost	2893	2732	2948	3122
Medicare Cost (Casemix-Adjusted)	2754	2470	2575	2707
Total Cost	2786	2826	3042	3289

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports

TABLE 12

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF HOSPITAL COST PER MEDICARE DISCHARGE BY PAYMENT PERIOD (INFLATION ADJUSTED)

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	$1075	$984	$1075	$1156
CV	43	41	42	42
Percentiles				
99th	6120	5635	6093	6351
95th	4583	4294	4670	4968
90th	3955	3717	4000	4308
75th	3036	2898	3100	3349
50th	2226	2168	2321	2496
25th	1754	1690	1793	1910
10th	1415	1386	1442	1517
5th	1247	1216	1280	1349
1st	936	941	940	990

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports.

TABLE 13

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF HOSPITAL COST PER MEDICARE DISCHARGE BY PAYMENT PERIOD (INFLATION/CASEMIX ADJUSTED)

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	$915	$777	$826	$889
CV	38	35	36	36
Percentiles				
99th	5474	4770	5001	5279
95th	4229	3715	3921	4173
90th	3692	3262	3427	3650
75th	2918	2646	2716	2880
50th	2253	2083	2157	2276
25th	1838	1699	1747	1823
10th	1515	1431	1459	1520
5th	1346	1291	1305	1372
1st	1058	1013	947	1029

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports.

TABLE 14

PERCENTILES, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF HOSPITAL COST PER DISCHARGE BY PAYMENT PERIOD (INFLATION ADJUSTED)

	TEFRA	PPS-1	PPS-2	PPS-3
Standard Deviation	$909	$929	$982	$1075
CV	40	40	39	39
Percentiles				
99th	5576	5631	5873	6590
95th	3975	4113	4452	4791
90th	3491	3551	3777	4161
75th	2716	2792	3004	3241
50th	2077	2146	2316	2515
25th	1658	1700	1862	2023
10th	1361	1391	1518	1662
5th	1221	1245	1353	1467
1st	963	1009	1068	1131

N = 3018

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports.

Table 15 shows mean cost per discharge by PPS gain quartile for each payment period. There is definite evidence of convergence here: in hospitals under greater financial pressure from PPS--the higher cost hospitals--cost per discharge rose less rapidly. For example, in the lowest gain quartile, casemix-adjusted Medicare cost per discharge fell from 3236 dollars to 2964 dollars from Tefra to PPS 3. Conversely, in the highest gain quartile, mean costs rose from 1758 dollars to 1960 dollars over the same period. Similar convergence is evident for unadjusted Medicare costs and for costs for all cases.

Inflation and casemix adjusted, PPS reduced hospital cost per Medicare discharge by about 9 percent for one year. After that, Medicare costs resumed their upward spiral. Cost per discharge for all cases increased more steadily over this period, exceeding Medicare costs on an unweighted basis by PPS 3. Although PPS produced some short-run convergence in the cost distribution, by PPS 3, the degree of variation was not very different than in Tefra. To the extent that PPS put hospitals under financial pressure, it was successful in limiting cost increases.

6.0 CHANGES IN WITHIN AND BETWEEN AREA VARIANCE IN LENGTH OF STAY AND COSTS

This section further explores the change in variation in LOS and cost per discharge between the Tefra and third PPS year. Analysis of variance techniques are used to determine how much of the change in variance occurred between area versus within area. Four area definitions are used: the Census region and Census Division are broad regional groupings, states are intermediate in size, while Metropolitan Statistical Areas (MSAs) and state rural areas are much narrower definitions of markets. The decompositions of variance which are presented in this section are based on equation (11) of Section 4.2. That equation shows that the percentage change in the variance of LOS or costs between the Tefra and third PPS years is the sum of between and within area components. The between-area component is the product of the R-squared, or proportion of the total variance explained by the area groupings, and the percent change in the weighted variance of the area means around the overall mean. The within-area component is the product of one minus the R-squared and the percent change in the weighted average of within-area variances. Section 6.1 considers Medicare and total LOS and Section 6.2 considers Medicare and total cost per discharge.

6.1 Length of Stay

Between Tefra and PPS 3, the variance in unadjusted Medicare LOS changed very little: it fell by only 3.4 percent (Table 16). Virtually all of this slight decline was due to a convergence across area rather than within area.

TABLE 15

HOSPITAL COST PER DISCHARGE BY EXPECTED PPS GAIN QUARTILES AND PAYMENT PERIOD (ADJUSTED FOR INFLATION)

	TEFRA	PPS-1	PPS-2	PPS-3
Medicare Cost				
Gain Quartiles:				
1	$3399	$3095	$3277	$3469
2	2769	2643	2812	2953
3	2297	2239	2403	2580
4	1690	1705	1866	2057
Medicare Cost (Casemix-Adjusted)				
Gain Quartiles:				
1	3236	2787	2848	2964
2	2699	2446	2521	2603
3	2281	2123	2190	2326
4	1758	1701	1805	1960
Total Cost				
Gain Quartiles:				
1	2926	2940	3126	3352
2	2489	2544	2688	2909
3	2142	2235	2410	2611
4	1672	1767	1989	2208

N = 2781 (Medicare Cost)
N = 2796 (Total Cost)
1 = lowest quartile of financial gain from PPS;
4 = highest quartile of financial gain from PPS.

Note: Costs are in October 1982 dollars.

Source: Medicare Cost Reports.

TABLE 16

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF MEDICARE LENGTH-OF-STAY BETWEEN THE TEFRA AND THIRD PPS YEAR

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
3.4%	=	(.12)	(30.9%)	+	(.88)	(-0.4%)
	=	3.7%		-	0.3%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
3.4%	=	(.20)	(12.4%)	+	(.80)	(1.2%)
	=	2.5%		+	0.9%	

II. STATES

Total		Between	States		Within	States
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
3.4%	=	(.29)	(12.4%)	+	(.71)	(-0.3%)
	=	3.6%		-	0.2%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
3.4%	=	(.54)	(6.9%)	+	(.46)	(-0.8%)
	=	3.7%		-	0.4%	

N = 3018

Note: This decomposition is based on equation (11) in the text.

Source: Medicare Cost Reports.

For instance, the between-region component of the variance reduction was 3.7 percent, while the within-region component actually increased by 0.3 percent (see the first panel of Table 16). The variance between regions fell by a substantial 30.9 percent, but since the four regions account for only 12 percent of total variance in LOS, the large drop in regional variance did not have a significant effect on overall variance.

Adjusted for casemix (Table 17), LOS variance declined by a larger 16.3 percent. About one-third of this reduction occurred between regions or Divisions, about half between states, and about two-thirds betweeen MSAs/state rural areas. The between area variances fell by a larger proportion than the within area variances. For example, the between-state variance fell by 24.9 percent while within-state variance fell by only 12.2 percent. However, the larger proportion of the total variance occurring within-state means that about half of the total variance reduction occurred within-state.

The variance in (unadjusted) total LOS fell by a similar proportion to casemix-adjusted Medicare LOS, 13.5 percent (Table 18). A higher proportion of this reduction occurred within area than was true for Medicare LOS. For example, 60 percent of the reduction occurred within MSAs/state rural areas as opposed to 25 percent for casemix adjusted Medicare LOS (Table 17).

6.2 Cost per Discharge

The variance in Medicare cost per discharge (inflation, but not casemix adjusted) rose by 15.7 percent from Tefra to PPS 3 (Table 19). Most of this divergence occurred within region, Division, and state, and a majority within MSAs/state rural areas. The only variance to fall was the between-regions variance, which declined by 28.5 percent. However, since regional differences account for only 6 percent of the total variance this had little effect in reducing the overall variance.

Adjusted for casemix as well as inflation (Table 20), the variance in Medicare cost per case fell by 5.6 percent between Tefra and PPS 3. Several numbers in Table 20 are striking. First, the between-region variance fell by 44.1 percent, although again, since regions do not account for much of the overall variance, this compression had little effect overall. Second, the between-MSA/state rural area variance fell by 14.1 percent, but within MSAs/rural areas, cost per case actually diverged by 7.2 percent.

Even adjusted for inflation, the variance in cost per case for all discharges increased by over 80 percent from Tefra to PPS 3 (Table 21). As was true for Medicare costs, most of this increase occurred within area. For example, 54.2 percentage points of an 80.8 percent increase occurred within MSAs and state rural areas, only 26.6 percentage points between these areas.

TABLE 17

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF MEDICARE LENGTH-OF-STAY (ADJUSTED FOR CASEMIX) BETWEEN THE TEFRA AND THIRD PPS YEAR

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
$\%\Delta\sigma^2$		$R\ ^2$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
16.3%	=	(.15)	(38.4%)	+	(.85)	(12.5%)
	=	5.8%		+	10.6%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
$\%\Delta\sigma^2$		$R\ ^2$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
16.3%	=	(.23)	(25.9%)	+	(.77)	(13.5%)
	=	5.9%		+	10.4%	

II. STATES

Total		Between	States		Within	States
$\%\Delta\sigma^2$		$R\ ^2$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
	=	(.32)	(24.9%)	+	(.68)	(12.2%)
16.3%	=	8.0%		+	8.3%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
$\%\Delta\sigma^2$		$R\ ^2$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
16.3%	=	(.55)	(22.4%)	+	(.45)	(8.8%)
	=	12.3%		+	4.0%	

N = 3018

Note: This decomposition is based on equation (11) in text.

Source: Medicare Cost Reports.

TABLE 18

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF TOTAL LENGTH OF STAY BETWEEN THE TEFRA AND THIRD PPS YEAR

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$	+	$(1-R)^2$	$\%\Delta\sigma^2$
13.5%	=	(.09)	(32.2%)		(.91)	(11.7%)
	=	2.9%		+	10.6%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R)^2$	$\%\Delta\sigma^2$
13.5%	=	(.13)	(22.6%)	+	(.87)	(12.1%)
	=	3.0%		+	10.5%	

II. STATES

Total		Between	States		Within	States
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R)^2$	$\%\Delta\sigma^2$
13.5%	=	(.20)	(19.5%)	+	(.80)	(12.0%)
	=	3.9%		+	9.6%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R)^2$	$\%\Delta\sigma^2$
13.5%	=	(.37)	(14.4%)	+	(.63)	(13.0%)
	=	5.4%		+	8.1%	

N = 3018

Note: This decomposition is based on equation (11) in the text.

Source: Medicare Cost Reports.

TABLE 19

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF MEDICARE COST PER HOSPITAL DISCHARGE BETWEEN THE TEFRA AND THIRD PPS YEAR (INFLATION ADJUSTED)

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
-15.7%	=	(.06)	(28.5%)	+	(0.94)	(-18.4%)
	=	1.6%		-	17.3%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
-15.7%	=	(.15)	(-10.2%)	+	(.85)	(-16.7%)
	=	-1.6%		-	14.2%	

II. STATES

Total		Between	States		Within	States
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
-15.7%	=	(.25)	(-11.7%)	+	(.75)	(-17.1%)
	=	-2.9%		-	12.8%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
$\%\Delta\sigma^2$		$R^{\ 2}$	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
-15.5%	=	(.62)	(-11.9%)	+	(.38)	(-21.2%)
	=	-7.4%		-	8.1%	

N = 3018

Note: This decomposition is based on equation (11) in the text.

Source: Medicare Cost Reports.

TABLE 20

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF MEDICARE COST PER HOSPITAL DISCHARGE BETWEEN THE TEFRA AND THIRD PPS YEAR (INFLATION/CASEMIX ADJUSTED)

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
%$\Delta\sigma^2$		R^2	%$\Delta\sigma^2$		$(1-R)^2$	%$\Delta\sigma^2$
5.6%	=	(.05)	(44.1%)	+	(.95)	(3.5%)
	=	2.2%		+	3.3%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
%$\Delta\sigma^2$		R^2	%$\Delta\sigma^2$		$(1-R)^2$	%$\Delta\sigma^2$
5.6%	=	(.15)	(7.5%)	+	(.85)	(5.2%)
	=	1.1%		+	4.5%	

II. STATES

Total		Between	States		Within	States
%$\Delta\sigma^2$		R^2	%$\Delta\sigma^2$		$(1-R)^2$	%$\Delta\sigma^2$
5.6%	=	(.26)	(7.9%)	+	(.74)	(4.7%)
	=	2.0%		+	3.5%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
%$\Delta\sigma^2$		R^2	%$\Delta\sigma^2$		$(1-R)^2$	%$\Delta\sigma^2$
5.8%	=	(.61)	(14.1%)	+	(.39)	(-7.2%)
	=	8.6%		-	2.8%	

N = 3018

Note: This decomposition is based on equation (11) in the text.

Source: Medicare Cost Reports.

TABLE 21

DECOMPOSITION OF PERCENT DECREASE IN VARIANCE OF OVERALL COST-PER-DISCHARGE BETWEEN THE TEFRA AND THIRD PPS YEAR

I. FOUR CENSUS REGIONS

Total		Between	Region		Within	Region
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
	=	(.10)	(-35.6%)	+	(.90)	(-87.7%)
-82.4%	=	-9.0%		-	78.8%	

II. NINE CENSUS DIVISIONS

Total		Between	Division		Within	Division
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
	=	(.17)	(-29.8%)	+	(.83)	(-93.2%)
-82.4%	=	-5.1%		-	77.3%	

II. STATES

Total		Between	States		Within	States
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
	=	(.27)	(-39.9%)	+	(.73)	(-98.1%)
-82.4%	=	-10.8%		-	71.6%	

III. MSAs/STATE RURAL AREAS

Total		Between	MSA		Within	MSA
$\%\Delta\sigma^2$		R^2	$\%\Delta\sigma^2$		$(1-R\ )^2$	$\%\Delta\sigma^2$
	=	(.53)	(-50.2%)	+	(.47)	(-115.3%)
-80.8%	=	-26.6%		-	54.2%	

N = 3018

Note: This decomposition is based on equation (11) in the text.

Source: Medicare Cost Reports.

7.0 CONCLUSION

Did PPS compress variation in hospital LOS and cost per discharge? Yes, but not dramatically, and not for all cost variants. The variance in Medicare LOS fell by 3.4 percent from Tefra to PPS 3, and by 16.3 percent adjusted for reported casemix. The variance in total LOS dropped by 13.5 percent over the same period. Adjusted for hospital market basket inflation and casemix, the variance in Medicare cost per discharge fell by 5.6 percent over the three year period. Adjusted only for inflation, however, the variance in Medicare cost per discharge rose by 15.7 percent, and for all cases, this variance rose by over 80 percent.

The compression that did occur was due to larger reductions or smaller increases in LOS and costs by high-cost, long-LOS hospitals, which were put under more financial pressure by PPS, than by low-cost, low-LOS hospitals, which were under lesser financial pressure. The extent of compression was, however, limited by the responses of the low-LOS, low-cost hospitals. Despite being "winners" under PPS averaging, these hospitals responded to PPS by reducing LOS and restraining cost increases, rather than allowing LOS and costs to move rapidly upward towards the mean. Thus, the reductions in LOS and real costs by the long-LOS, high-cost hospitals were not enough to dramatically narrow the large gap between the upper and lower tails of the LOS and cost distributions.

There was more compression between area than within area. The regional variance in both LOS and Medicare cost per case fell by nearly 30 percent or more. However, since regional differences account for little of overall variance, this compression had only a minor effect on overall variance. About three-quarters of the casemix-adjusted decline in the variance of Medicare LOS and all of the convergence in casemix/inflation-adjusted Medicare cost per discharge occurred between MSAs and state rural areas. Thus, PPS averaging seems to have reduced inter-area differences in LOS and cost which were sheltered under cost-based reimbursement, but competitive or other area-specific factors did not result in intra-area convergence.

The effects of PPS may have been of the "one-time" variety. Major reductions in LOS and real costs occurred between Tefra and the first year of PPS. After that, the LOS distribution has been quite stable and cost per discharge has resumed its upward march. Variation in both the LOS and cost distributions is increasing, and by the third year of PPS had approached the level observed in Tefra. Thus, whether PPS will have any significant long-run effects in reducing variation in LOS and costs is unclear.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES-- MULTIHOSPITAL SYSTEM AFFILIATIONS AMONG ACUTE-CARE HOSPITALS UNDER MEDICARE'S PROSPECTIVE PAYMENT SYSTEM

Working Paper

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APPENDIX A DATA AND FILE CONSTRUCTION

1.0 INTRODUCTION

Multihospital systems have grown rapidly both in number and in size during the last decade.* They now represent a large portion of the total acute-care hospital industry (2255 out of 5649 acute-care hospitals in 1986). Is this growth due to economies of scale from central management that give these hospitals a competitive edge? Were these hospitals better able to adapt to the changes in reimbursement and utilization review that have occurred in the 1980s? The answers to those questions will not only shed light on the structure of the hospital industry, they will lead to better informed policy in an era of cost consciousness.

This paper describes these multihospital systems and examines the impact of Medicare's acute-care prospective payment system (PPS) on the hospitals in them. This study is a significant addition to a growing literature on multihospital systems. It describes the universe of short-term acute-care facilities rather than a sample. In addition, this research compares measures of cost and utilization at two points in time rather than restricting the comparison of system hospitals with their freestanding counterparts only in a pre-PPS world.

Previous studies of multihospital systems have used several definitions of a system. They involved primary data collection and consequently had to restrict the size of the study samples. For example, some included all organizations that owned or managed two or more hospitals; others focussed only on systems that owned or managed three or more facilities. In addition, some studies examined systems that both owned and managed hospitals, while others restricted analysis to systems that did one or the other but not both. Finally, some prior studies looked at multihospital systems in all ownership categories, but many described systems in only one category (e.g., non-profit systems or investor-owned systems). This report encompasses all types of multihospital systems and attempts to distinguish among them by testing for statistically significant differences in their costs or utilization. This contributes to an overall picture that all systems are not alike.

A major concern of prior research on hospitals in multihospital systems was to determine whether they are more profitable than independent facilities. Most studies compared financial ratios and concluded that system hospitals are more profitable than their freestanding counterparts (Lewin et al., 1981, Wheeler et al., 1982, Kralewski et al., 1984, Levitz et al., 1985). These studies also concluded that this improved profitability was due to higher prices. This is not inconsistent with a few studies that note that costs per patient in system hospitals are higher than in their freestanding counterparts (Ferber, 1971; Coyne, 1982; Levitz, et al., 1985). Higher costs may justify higher prices as well as be covered by them.

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*The American Hospital Association (AHA 1988) defines a multihospital system as "two or more hospitals owned, leased, sponsored, or contract managed by a central organization."

System hospitals had slower growth in average cost per case than their independent counterparts during the 1970s (Cooney and Alexander, 1975; Wheeler, 1982). One reason for a slower rate in the increase of expenses may be shorter lengths of stay per patient in system hospitals (Ferber, 1971; Cooney and Alexander, 1975). However, more recent data indicated no significant difference in average lengths of stay between system and non-system hospitals (Kralewski, 1984) or even found longer lengths of stay in system hospitals (Levitz et al., 1985). Another apparent difference is the financial portfolios of system versus freestanding hospitals. System hospitals often have more debt financing (Wheeler et al.,1982, Alexander et al., 1984, Levitz et al., 1985).

Most prior studies of system hospitals have relied on simple comparative statistics. Consequently, differences in input prices and the mix of cases could not be held constant in comparisons of costs per case. One exception is a study by Coyne (1982), which showed that system hospitals were more costly per case, except for county government systems, when a number of demand and supply factors were accounted for. The numbers of hospitals analyzed were very small, however.

Coyne also found in a regression explaining admissions per bed for county-owned hospitals that hospital depreciation and the percent of insured state population participating in the largest HMO had a significantly negative effect on admissions. State regulations and those participating in an HMO, on the other hand, had a significant positive impact upon admissions. Finally, in a regression of full time employees per 100 occupied beds, Coyne found that the existence of state regulations increased full time employees in religious-owned hospitals whereas the occupancy rate and hospital depreciation decreased the number of employees in non-profit hospitals. The occupancy rate increased the number of employees in investor-owned chains while surgical operations and the number of people participating in an HMO was positively correlated with the number of employees.

Mullner et al., (1984) showed, through multivariate regression, that the population, the percent share of hospital beds, and the total margins of non-profit, non-government hospitals have a positive and statistically significant effect on the percentage change in proprietary chains' share of hospital beds. From this, the authors concluded that the growth of proprietary hospitals tends to be in areas with favorable market conditions, that is, in areas with a large population, high income per capita and where proprietary hospitals have already captured a large percentage of the market share through bedsize.

Renn, et al., (1985) estimated several regressions of performance measures of system and freestanding hospitals for 1980. Their results showed that there are no major differences between hospitals with respect to system affiliation. That is, there are no differences in performance or cost of profit chain hospitals versus profit independent hospitals, for example. The differences lie in profit versus non-profit hospitals of the same system affiliation type. Therefore, consolidation of hospitals has not increased or decreased efficiency. The authors characterize investor-owned chains as charging more and earning greater profits with lower occupancy rates. The profits, then, are coming from charging more, not from costing less.

Whether system hospitals are more efficient due to economies of scale has not been answered by previous studies, although system hospitals do seem to be more profitable than their independent counterparts. An issue raised in some of the articles on multihospital systems was that their costs decreased and their financial status improved after an initial adjustment period of about three years. Therefore, because much of the research on multihospital systems has concentrated on the characteristics of hospitals that have recently joined systems, the conclusions may be biased. An important limitation of the previous research on hospital systems is that the samples were generally very small. We address these two problems by including all acute-care hospitals that were in systems in 1982 and 1986 in the database, thereby providing information on all system hospitals, both old and new. Additionally, our data is more comprehensive and more recent than that of other studies: we have hospital information for system hospitals from 1982 to 1986 and we have data on the ownership type, size, and location of their systems. Both simple descriptions of systems and their hospitals are provided as background to regression analyses of the differences in costs between system and non-system hospitals.

Section 2.0 describes the characteristics of multihospital systems and their hospitals that existed in 1987. Section 3.0 discusses a methodology and presents the results of multivariate analyses comparing the costs per case of system and non-system hospitals under TEFRA and PPS-3. The databases are discussed in Appendix A.

2.0 DESCRIPTION OF MULTIHOSPITAL SYSTEMS

In this chapter, we provide basic descriptions of both the systems and the hospitals owned or managed by them. Information on each multihospital system from the AHA Guide (1988, Section B) was used to create an analytic file, which was merged with hospital-level data from both the AHA annual surveys and Medicare Cost Reports. (See Appendix A.) These files and the tables published by the AHA (1988, p. 3B) are the sources for this descriptive section.

2.1 Ownership and Scale of Multihospital Systems

One common image of multihospital systems is that they are all large for-profit chains. The AHA's descriptive tables of health care systems bear this out in one respect: 47 percent of all hospitals in health care systems are owned, leased, or managed by for-profit chains (Table 4). One quarter of these hospitals are under management contracts. Only 21 percent of all multihospital systems are for-profit, however, (64 of 303, AHA Table 1) from which we can infer that each of these chains contains more hospitals than the average not-for-profit system.

This conclusion is demonstrated in our Table 2-1, which groups 302 multihospital systems by whether they contain two or more than two hospitals.* Thirty-eight percent of all the systems have only two. The "Other not-for-profit" category (which contains many government and local community systems), is even more dominated by small systems: 48 percent of these 141 systems have only two hospitals. However, a quarter to a third of the church and for-profit chains are also this small.

Systems with only two or three hospitals are not likely to extend beyond a local area or a state's borders. Table 2-2 shows that the majority of all multihospital systems (167 of 302) are located in only one state. Another 122 are regional, in that they have hospitals located in two or more states and may even cross borders between two of the Census Bureau's four regions. However, only thirteen of all systems are national in scope, with hospitals widely spread in more than two regions.

Non-Catholic church and for-profit systems comprise 92 percent of the national chains. This representation is disproportionate, however. From the first column, we see that non-Catholic, church-owned systems comprise only six percent of all multihospital systems but are 15 percent of the thirteen chains

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*One system that operates only in Hawaii is excluded from these tables.

TABLE 2-1

DISTRIBUTION OF MULTIHOSPITAL SYSTEMS BY SIZE WITHIN OWNERSHIP TYPE, 1987*

	Number of Systems	Total	Two Hospitals	More Than Two Hospitals
Total	302	100%	38%	62%
Catholic	80	100	31	69
Other Church	17	100	24	76
Not For Profit	141	100	48	52
For Profit	64	100	30	70

*Nonwaivered states excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

TABLE 2-2

DISTRIBUTION OF SYSTEMS BY OWNERSHIP WITHIN GEOGRAPHIC DISPERSION AREA, 1987*

	GEOGRAPHIC DISPERSION			
	Total	National	Regional	State
Number of Systems	302	13	122	167
Total	100%	100%	100%	100%
Catholic	26	0	41	18
Other Church	6	15	4	6
Not For Profit	47	8	21	68
For Profit	21	77	34	8

*Nonwaivered states excluding Alaska and Hawaii.

Source: 1988 AHA Guide.

that are national in scope. For-profit chains, with only 21 percent of the total number of systems, are 77 percent of the national chains.

Forty-one percent of regional health care systems are owned by Catholic orders. Thirty-four percent are for-profit, while only one in five is neither church-owned nor for profit. This last group dominates the state or local category, with 68 percent of all systems that do not extend beyond one state. Another 18 percent of the state systems are Catholic, and fewer than one in six is in either of the other two categories.

National chains are larger, in terms of the number of hospitals, than regional systems, which are larger, in turn, than systems located in a single state. This is generally true whether one considers the hospitals that are owned by the system corporation or those that are managed. Table 2-3 summarizes the average numbers of hospitals owned or managed by multihospital systems by ownership and geographic size. The largest systems are for-profit chains operating with a national scope. There are ten of these and, on average, they each owned 54 hospitals and managed another 27 in 1987. The next largest are the two non-Catholic church systems, which owned 30 hospitals, on average, and managed three more. The single non-church, not-for-profit chain owned 20 hospitals.

Among regional systems, the largest are the non-Catholic church-owned, with eleven hospitals and an additional three under management contract. The other three ownership groups owned seven or eight facilities and managed one to three more. These systems are about three times larger than the state systems, however, which owned two or three and managed an average of about one, regardless of ownership status.

The hospitals owned by for-profit systems are considerably smaller, on average, than those not owned by not-for-profit systems: the mean is 131 beds for hospitals that are owned by for-profit chains versus 233 in those owned by not-for-profit systems (derived from AHA Table 3, p. B3). Hospitals managed by either type of system are smaller: 103 and 97 beds, respectively. Church-related systems contain larger hospitals, on average, than those that are classified as other non-profit organizations (usually local governments). Church-related system hospitals average 248 beds compared to 218 in those that are not church-related.

These differences in hospital size affect the potential market impact of decisions implemented by a given hospital chain. For example, in Table 2-4 we see that the non-Catholic church systems operating at the national level own more beds, on average, than the for-profit systems do (8,477 versus 7,769), although they own only 60 percent as many hospitals per health care system (30 versus 54). Among regional systems, the average for-profit has a markedly

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TABLE 2-3

MEAN NUMBER OF HOSPITALS PER SYSTEM BY OWNERSHIP BY GEOGRAPHIC DISPERSION, 1987*

	Geographic Dispersion					
	National		Regional		State	
Ownership	Owned	Managed	Owned	Managed	Owned	Managed
Catholic	0	0	7	1	2	1
Other Church	30	3	11	3	3	a
Not For Profit	20	0	7	3	3	1
For Profit	54	27	8	1	2	1

*Unwaivered states excluding Alaska and Hawaii.

[a] Less than 0.5

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

TABLE 2-4

MEAN NUMBER OF BEDS BY OWNERSHIP BY GEOGRAPHIC DISPERSION, 1987*

	Geographic Dispersion					
	National		Regional		State	
	Owned	Managed	Owned	Managed	Owned	Managed
Catholic	0	0	1843	122	568	80
Other Church	8477	244	1820	342	992	33
Not For Profit	946	0	1144	206	773	54
For Profit	7769	2915	818	54	345	76

*Nonwaivered states excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicae Cost Reports, Provider of Service File.

smaller market share than the three types of not-for-profit chains, which control far more beds each, through both ownership and management contract. Finally, at the level of state systems, church and other not-for-profit systems own greater inpatient capacities (568 to 992) than do the for-profit systems (345). This may mean that not-for-profit system hospitals may possess more market power than those that are investor-owned because the former control greater amounts of capacity within market areas. The not-for-profit hospitals may also be less costly because of economies of scale from having larger hospitals in their systems.

Which measure of scale best captures the benefits or drawbacks of being in a multihospital system? Systems with large hospitals may have lower average costs than other systems because the overhead costs are spread over more patients (assuming the same occupancy rate). On the other hand, systems with more hospitals may have lower administration costs because a central system can be averaged over more facilities.

2.2 Location and Growth in the Number of Hospitals in Multihospital Systems

Section 2.1 summarized several descriptive points about the multiple hospital chains themselves. Here we consider the hospital facilities within those systems: where they are located and the rates of growth in the numbers of facilities between 1982 (the first year AHA reports a sizeable number) and 1986 (the most recent year available).

Table 2-5 presents the distribution of system hospitals in the non-waivered states (excluding Alaska and Hawaii) by ownership category within urban and rural locations for 1982 and 1986. The rates of change are calculated overall and for each ownership category. The number of rural hospitals in multihospital systems grew from 677 to 880 during this four-year span, a 30 percent change. The number of urban system hospitals grew only 27 percent from 978 to 1,237 in the same time span.

Government-owned hospitals in systems are a larger proportion of the rural total compared to the number in urban areas. In 1982, they were 23 percent of all rural system facilities versus only 7 percent of all urban ones. In both locations, the numbers of government-owned hospitals grew by about 40 percent, leading to a marginal increase in their shares within urban and rural areas.

The number of church-owned hospitals in systems increased by only about five percent in both urban and rural areas. This reduced their relative shares from 31 and 24 percent of all 1982 system hospitals, respectively, to 26 and 19 percent in 1986. This category includes Catholic and non-Catholic systems because the AHA annual survey categorizes hospital ownership differently from system ownership.

TABLE 2-5

SYSTEM HOSPITALS BY URBAN/RURAL LOCATION BY OWNERSHIP, NONWAIVERED STATES*

Hospital Ownership[a]	1982		1986		Percent Change	
	Rural	Urban	Rural	Urban	Rural	Urban
Number of Hospitals	677	978	880	1,237	30%	27%
Government	23%	7%	24%	8%	39%	40%
Church	24	31	19	26	4	5
Other Nonprofit	33	25	35	28	37	38
For Profit	20	36	22	38	38	34

*Excluding Alaska and Hawaii.

[a] Hospital ownership differs from ownership of multihospital systems because systems can lease or manage hospitals. Thus, a for-profit system can manage government or other non-profit facilities.

Source: Merged AHA Annual Surveys, Medicare Cost Reports and Provider of Service File.

Other non-profit systems are somewhat more important in rural areas than in urban ones. Among rural hospitals in chains, they are the modal group, accounting for a third of all rural chain facilities. They increased in both rural and urban areas by almost 40 percent between 1982 and 1986. For-profit hospitals are the modal group in urban areas with over 35 percent of the chain facilities in both years. However, their number increased relatively faster among rural systems than in urban areas.

Much of the 27 to 30 percent growth in the number of hospitals in systems involves hospitals under management contract with a multihospital health care system. Owning and leasing hospitals may not be as profitable in the 1980s as it once appeared. In addition, many small hospitals, faced with major changes in the competitive environment have chosen to find professional chief administrators and have contracted for management because it is often less costly and time consuming than mounting a search for independent officers willing to shoulder the responsibilities of a small institution.

Where are system hospitals? Table 2-6 shows that their location is predicated to some extent on their ownership. For example, local government hospitals in health care systems are likely to be in any of the Census divisions except the Northeast but church-owned system hospitals are predominantly (over two to one) in the Midwest in both years. Over 30 percent of hospitals in church-owned systems are in the East North Central division alone. This contrasts markedly with for-profit chain hospitals, which are most prevalent in the South (69 percent of all for-profit systems hospitals) and in the Pacific division (another 20 percent). This proportion, did not change between 1982 and 1986. Other non-profit systems hospitals are more evenly dispersed, although they are under represented in the West South Central division, which, because of Texas, has a large number of all hospitals.

2.3 Comparison of System and Non-system Hospitals

This section compares system hospitals with their freestanding counterparts in TEFRA and PPS-3 to show any changes occurring between these periods. It describes differences in location, ownership, professional affiliations, teaching status, utilization patterns, costs, and financial margins.

Table 2-7 categorizes all hospitals in non-waivered states by their system affiliations and by geographic location or other hospital characteristic. For each group of characteristics, except the one entitled "Other Status," the non-system and system hospitals are described as the percentage of all hospitals that they account for during each time period.

TABLE 2-6

DISTRIBUTION OF SYSTEM HOSPITALS BY OWNER BY REGION, 1982 AND 1986*

	OWNERSHIP							
	Local Government		Church		Other Nonprofit		For Profit	
	1982	1986	1982	1986	1982	1986	1982	1986
Number of Hospitals	223	311	466	488	474	652	494	666
Total	100%	100%	100%	100%	100%	100%	100%	100%
New England	1	1	2	2	1	1	a	a
Mid Atlantic	a	1	2	2	6	6	a	a
South Atlantic	20	18	7	7	15	17	25	25
East North Central	9	8	31	32	13	14	1	2
East South Central	9	9	6	7	6	5	18	17
West North Central	17	16	19	16	18	17	2	4
West South Central	18	25	12	13	8	10	26	27
Mountain	10	9	8	7	16	14	5	5
Pacific	16	13	13	15	17	16	21	20

*Nonwaivered states excluding Alaska and Hawaii.

[a] Less than .5%.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

TABLE 2-7

DESCRIPTIVE CHARACTERISTICS OF SYSTEM AND NONSYSTEM HOSPITALS PRE/POST PPS

Hospital Characteristics	TEFRA			PPS-3		
	Non-System	System	Total*	Non-System	System	Total*
Regional Location:						
Northeast	3%	a	3%	3%	1%	4%
North Central	24	8	32	23	10	33
South	30	16	46	26	20	46
West	10	8	18	8	10	18
Total*	67	33	100	60	40	100
Metropolitan Status:						
Urban	27%	19%	46%	24%	22%	46%
Rural	39	15	54	36	18	54
Total*	67	33	100	60	40	100
Ownership:						
Government	27%	4%	31%	23%	5%	28%
Other Non-Profit	33	11	44	32	14	45
Religious	2	7	9	2	7	9
Investor-Owned	4	12	16	3	14	17
Total*	66	33	100	60	40	100
Teaching Status:						
Non-Teaching	58%	29%	87%	52%	34%	87%
Minor Teaching	7	4	11	7	5	12
Major Teaching	1	1	2	1	a	1
Total*	67	33	100	60	40	100
Other Status:						
Affiliated With Medical School	6%	3%		5%	4%	
Member COTH	2	1		2	1	
JCAH Accredited	46	28		41	33	

Source: Merged AHA and MCR data
EXK603101988

For example, in the description of hospitals by regional location during TEFRA, the non-system hospitals make up 67 percent of all hospitals (3 + 24 + 30 + 10), while system hospitals account for 33 percent; (3 + 16 + 8 + a). Summed together, the non-system and system hospitals in all four regions are 100 percent of all hospitals in the dataset.

In terms of regional location, Table 2-7 shows that the majority of all hospitals were located in the South and North Central Census regions during TEFRA (46 and 32 percent, respectively). The Northeast contains the smallest number of hospitals with only three percent of the nonwaivered states' total, followed by the West, which accounts for only 18 percent. This pattern of concentration in the South and and North Central continued in PPS-3.

The major change between TEFRA and PPS-3 was the growth in the number of system hospitals. The proportion of hospitals in systems grew from one third to two fifths of all short-term, acute-care facilities over this three year period. (In this respect, the dataset used for these descriptions is representative of the nation as a whole, which also had 40 percent system facilities in 1986.) The growth rate was about the same in all regions: about a 25 percent increase in the proportions of all hospitals that were in multihospital systems. The South maintained its position as having roughly half of all system hospitals but the West actually had system facilities become the majority during the first three years of PPS.

With respect to location in a metropolitan area, roughly the same numbers of hospitals became affiliated with systems in both urban and rural counties (three percent of all hospitals in each case), but because the proportion of rural hospitals in systems in TEFRA was lower, the growth rate of rural system-affiliated hospitals was greater. In rural areas, system affiliation grew from 15 percent of all hospitals to 18 percent in PPS-3, a 20 percent rate of growth. In urban areas, 19 percent of all hospitals were in systems in TEFRA but this increased to 22 percent in PPS-3.

Across ownership categories, there was significant change in the numbers of hospitals in three of the four: only hospitals owned by religious groups did not change and more than three quarters of these were already in multihospital systems in TEFRA. Local government hospitals decreased during the three years from TEFRA through PPS-3. Because the dataset includes hospitals with all four years of data, the number in the sample does not change, therefore the change in the proportion is due to changes in the owners, not to mergers, closures, etc. Roughly ten percent of the hospitals owned by governments in TEFRA (3 out of 31 percent) were investor-owned or other non-profit hospitals in PPS-3. The figures suggest that the ones that changed owners were non-system hospitals and that they joined systems by being acquired or entering management contracts. In addition, government hospitals that did not change owners also joined systems. This category grew from four to five percent of all hospitals in the dataset.

In addition to the changes in ownership, other non-profit and investor-owned hospitals increasingly joined multihospital systems. The majority of investor-owned hospitals (14 of every 17) were in multi-facility chains by the third year of PPS, while almost one in three of the other non-profit hospitals were as well.

Table 2-7 shows that most of the changes in system affiliation occurred for non-teaching hospitals. One in three non-teaching facility was system-affiliated in TEFRA but two of five were in PPS-3. With respect to other status characteristics, systems contained proportional numbers of hospitals with a medical school affiliation in both TEFRA and PPS-3. That is, one of every three hospitals was in a system in TEFRA and one of every three hospitals affiliated with a medical school was, as well. Similarly, for Council of Teaching Hospital facilities, systems maintained proportional representation in both years.

With respect to JCAH accreditation, however, system hospitals were more likely to have it, in either year. In TEFRA, only about two-thirds of non-system hospitals (46/67) had JCAH accreditation compared to 85 percent of all affiliated hospitals (28/33). This changed only marginally by the third year of PPS.

In sum, then, among the hospitals we examine here, system affiliation increased markedly during the first three years of PPS. Affiliation is most prevalent in the South and West, and in urban rather than rural areas. System hospitals tend to be either investor-owned or non-profit institutions that are not religiously or government-owned. They tend to be non-teaching facilities but are more likely to have JCAH accreditation than non-system hospitals.

Table 2-8 describes the size and utilization of hospitals in and out of systems in TEFRA and PPS-3. The average system hospital was a little larger than its freestanding counterpart in both years. However, system hospitals reduced their capacity more: from 165 beds to 144 compared to a reduction from 138 to 126 for non-system hospitals. This may be attributable to a greater reduction in inpatient utilization for system hospitals. The number of admissions fell 20 percent (from 500 to 400 per month) in system hospitals compared to a 14 percent decrease (from 431 to 377) for the average non-affiliated hospital. The number of Medicare admissions decreased at about the same rate, however, so that their share of total admissions remained the same between TEFRA and PPS-3.

TABLE 2-8

UTILIZATION OF SYSTEM AND NONSYSTEM HOSPITALS PRE/POST PPS*

	TEFRA		PPS-3	
	Non-System	System	Non-System	System
Mean:				
Beds	138	165	126	144
Admissions[a]	431	501	377	400
Percent Medicare Admissions	39%	37%	38%	37%
Occupancy Rate	57%	59%	44%	45%
Length of Stay	6.3	6.4	5.9	5.8
Inpatient Days[a]	3,149	3,559	2,544	2,672
Case Mix Index	1.0	1.0	1.1	1.1
Outpatients[a]	2,265	2,284	2,416	2,397
Wage Index 1987	.93	.96	.92	.96

*Nonwaivered states excluding Alaska and Hawaii.

[a] On a per month basis.

Source: Merged AHA and MCR data
EXK627102488

The contractions in bedsize kept the two types of hospitals roughly the same with respect to occupancy. System hospitals were marginally fuller in both years (59 versus 57 percent in TEFRA and 45 versus 44 in PPS-3). For both types of hospitals, inpatient utilization fell not only because of the drop in admissions but because the average length of stay declined. The decline was about half a day in non-system hospitals and somewhat greater than that among affiliated institutions. The combination of greater falls in admissions and a larger cut in the length of stay led to a 33 percent decline in average monthly inpatient days for system hospitals, from 3,559 to 2,672. Non-system hospitals experienced a 24 percent drop.

The two groups of hospitals were basically the same with respect to the mix of their Medicare cases. Both experienced a ten percent increase in casemix severity, as well, from indexes of 1.0 to 1.1 in three years. Outpatient utilization increased more among non-system hospitals, however. The average number of monthly visits increased from 2,265 to 2,416 for non-system hospitals but to only 2,397 in system-affiliated ones.

Finally, system hospitals were in higher wage areas, as measured by the HCFA wage index based on 1982 data. This did not change between TEFRA and the third year of PPS. It undoubtedly reflects the greater proportion of affiliated hospitals that are in urban areas.

Table 2-9 describes four cost characteristics of nonwaivered hospitals in TEFRA and PPS-3: the average cost per case across all inpatient admissions in each hospital (including capital as well as operating costs), the average Medicare operating cost per case (excluding capital and direct medical education costs), the percent of total operating costs that were collected as operating revenue, and the percent of total costs (including non-operating costs) collected as operating and non-operating revenue.

In both years, system hospitals were more costly per case than their freestanding counterparts. Average total cost per case in TEFRA was $2,535 in system hospitals, almost sixteen percent above the $2,193 calculated for the others. In PPS-3, the system affiliates were about 15 percent more costly per case ($3,486 versus $3,043, respectively). The higher costs existed for Medicare cases, as well. In TEFRA, average Medicare operating costs in system hospitals was $2,565, 18 percent above the $2,167 in non-system facilities. Medicare costs were held to a lower rate of increase in system hospitals, however. Among them, the increase was only 17 percent while in non-system facilities, the increase was 23 percent. This occurred despite the same relative mix of Medicare cases, as measured by the Medicare CMI, in both types of hospitals in each year.

TABLE 2-9

COST CHARACTERISTICS OF SYSTEM VERSUS NONSYSTEM HOSPITALS, PRE/POST PPS

	TEFRA		**PPS-3**	
	Non-System	**System**	**Non-System**	**System**
Average Cost/Case	$2,193	$2,535	$3,043	$3,486
Medicare Cost/Case (Excluding Capital and Medical Ed)	$2,167	$2,565	$2,669	$2,996
Percent of Operating Costs collected	98%	102%	97%	99%
Percent of Total Costs Collected	104%	105%	104%	103%

Source: Merged AHA and MCR data
EXK633102688

Despite having higher costs, system affiliates tended to do better financially than non-system hospitals. They collected a greater proportion of operating costs in both years. In TEFRA, they even did better than breaking even on operations, on average (102 versus 98 percent for non-system hospitals). When non-operating revenues are taken into account, system affiliates also did better, on average, than other hospitals in TEFRA and almost as well in PPS-3. This occurred despite the higher average total cost per case, which increased by over 35 percent in the three years for system hospitals.

Are system hospitals in every ownership category more costly than their freestanding counterparts? Table 2-10 describes the average cost per case for system and non-system hospitals by ownership type in TEFRA through PPS-3. Only investor-owned hospitals in systems are consistently more costly than their non-system counterparts, and only other non-profit hospitals in systems are less costly in each time period than their non-system counterparts. The average cost per case of hospitals in every ownership and system affiliation category increases consistently from TEFRA to PPS-3. However, other cost factors such as casemix and teaching are not taken into account. These cost differences might disappear if the variation in other characteristics were controlled for.

For investor-owned hospitals in systems the average cost per case grows from $2,870 in TEFRA to $3,992 in PPS-3, overall a 40% increase in average cost per case from TEFRA to PPS-3. A consistent increase in costs also occurs for non-system investor-owned hospitals, from $2,504 in TEFRA to $3,840 in PPS-3, overall a 50% increase in average cost per case. In TEFRA and PPS-1, system-affiliated investor-owned hospitals are about 15 percent more expensive than investor-owned non-system hospitals ($2,870 versus $2,504 and $3,108 versus $2,681, respectively). By PPS-2 the differential in costs between these two types of investor-owned hospitals decreases to 13 percent ($3,547 for investor-owned system hospitals and $3,132 for investor-owned non-system facilities), and by PPS-3 the average cost per case of investor-owned hospitals in systems is only 4 percent higher than the cost for their freestanding counterparts ($3,992 and $3,840, respectively).

Our dataset includes only hospitals that exist in all four time periods, therefore differences between TEFRA and PPS-3 are not due to differences in the samples of facilities. The observed compression between costs for system and non-system investor-owned hospitals from TEFRA to PPS-3 may be for a number of reasons: system hospitals may have increased their efficiency, non-system hospitals may have suffered more severe decreases in occupancy and

TABLE 2-10

AVERAGE COST PER CASE FOR SYSTEM AND NONSYSTEM HOSPITALS BY OWNERSHIP, TEFRA-PPS-3

	TEFRA	PPS-1	PPS-2	PPS-3
	Average Cost Per Case	Average Cost Per Case	Average Cost Per Case	Average Cost Per Case
Non-System Hospitals:				
Government Hospitals	$1,967	$2,143	$2,531	$2,803
Other Non-profit Hospitals	2,471	2,730	3,198	3,557
Religious Hospitals	2,442	2,705	3,028	3,533
Investor-Owned Hospitals	2,504	2,681	3,132	3,840
System Hospitals:				
Government Hospitals	$1,950	$2,155	$2,383	$2,907
Other Non-profit Hospitals	2,383	2,694	2,918	3,274
Religious Hospitals	2,678	2,874	3,179	3,508
Investor-Owned Hospitals	2,870	3,108	3,547	3,992

Source: Merged AHA and MCR data
EXK625102488

greater increases in average fixed costs per case, or non-system hospitals may have had to spend money to enhance their competitive positions in a period of increased competition for admissions. These and other causes remain to be investigated.

Religiously owned hospitals that are in systems had their average cost per case grow from $2,678 in TEFRA to $3,508 in PPS-3, a more than 30 percent increase in cost. The average cost per case of non-system religious hospitals grew from $2,442 in TEFRA to $3,533 in PPS-3, a 45% increase in cost. Religious hospitals in systems, like investor-owned hospitals, have higher costs than their non-system counterparts, with the exception of the PPS-3 period, again a possible indication of greater efficiency on the part of system hospitals or non-price competition leading to higher costs for non-system facilities. In TEFRA, the average cost per case of religiously owned system hospitals is 10 percent greater than the cost for non-system religious hospitals ($2,678 and $2,442, respectively), and in PPS-1 and PPS-2 the cost is about 5 percent greater ($2,874 versus $2,705, and $3,179 versus $3,028, respectively). Yet, in PPS-3 the average cost per case for religious hospitals in systems is $3,508 which is 1 percent less than the $3,533 average cost per case for non-system religious hospitals.

Between TEFRA and PPS-3 the average cost per case for government hospitals affiliated with systems grew by 50 percent, from $1,950 in TEFRA to $2,907 in PPS-3. The average cost per case for non-system government hospitals grew consistently from $1,967 in TEFRA to $2,803 in PPS-3, a more than 40 percent increase in cost. During TEFRA and PPS-2, government hospitals in systems have a lower average cost per case than non-system government hospitals, and in PPS-1 and PPS-3 the average cost per case of government hospitals in systems is higher than those for non-system government hospitals during this period. In TEFRA the average cost per case of government hospitals in systems was $1,950, almost 1 percent less than the average cost of $1,967 for non-system government hospitals during TEFRA. By PPS-1 the average cost per case of government hospitals in systems was less than 1 percent greater than for non-system government hospitals ($2,155 and $2,143, respectively). In PPS-2 the average cost per case of system affiliated government hospitals was almost 6 percent less than the cost for their freestanding counterparts ($2,383 and $2,531, respectively). In PPS-3, the average cost per case for government hospitals in systems was $2,907 which was 4 percent higher than the $2,803 cost for non-system government hospitals.

For non-religious non-profit hospitals affiliated with systems the average cost per case increased from $2,383 in TEFRA to $3,274 in PPS-3, an almost 40 percent increase in cost. For non-system other non-profit hospitals costs increased from $2,471 in TEFRA to $3,557 in PPS-3, a 44 percent increase in cost. Non-system other non-profit hospitals were the only non-system hospitals that consistently had a higher average cost per case than their system affiliated counterparts. In TEFRA the average cost per case of $2,471 for non-system other non-profit hospitals was 4 percent greater than their system counterparts' $2,383 per case. In PPS-1 the non-system facilities had an average cost per case of $2,730, only 1 percent greater than the $2,694 cost for other non-profit hospitals affiliated with systems. By PPS-2 and PPS-3 the cost for non-system other non-profit hospitals was close to 10 percent greater than the cost for their system affiliated counterparts ($3,198 versus $2,918, and $3,557 versus $3,274, respectively). This disproportionate increase in the average cost per case for non-system non-profit hospitals may indicate the same reasons as those discussed above.

Table 2-11 shows how well hospitals within each ownership category did with respect to collecting operating and total costs. In terms of covering operating costs out of patient revenues, investor-owned hospitals in systems performed the best in each of the four analytic years. On average, they consistently covered operating costs and received excess revenues of two to seven percent, depending on the year. One reason for this performance is suggested by the fact that their coverage of total costs was identical. These hospitals received virtually no non-operating revenues and thus may have been under great pressure to earn profits on their operations. The fact that they did this despite having higher costs per case is consistent with the finding of Renn, et al., that these hospitals charge higher prices.

Religious and other non-profit (but not government-owned) hospitals performed almost as well, whether they were in a system or not. They tended to break even or earn small operating margins. Once non-operating revenues are accounted for, religious and other non-profit hospitals perform as well or better than the investor-owned system hospitals, with positive net revenues in each of the four years.

Investor-owned hospitals that were not in multihospital systems tended not to perform as well as the above groups on either operations or over all. In two of the four years, their operations did not break even and in PPS-3 net total revenues were negative, with revenues comprising only 96 percent of total costs. However, the worst financial performers, in terms of covering operating expenses, were the government hospitals, whether system affiliated or not. These hospitals never broke even on operations, which is recognized as historically in keeping with their missions as public hospitals and the fact that many of them receive non-operating revenues as subsidies for these missions. The fact that these hospitals consistently covered total costs indicates that their other sources of funds maintained the level of support through the first three years of PPS.

TABLE 2-11

PERCENTAGE OF COSTS COLLECTED FOR NON-SYSTEM AND SYSTEM HOSPITALS BY OWNERSHIP, TEFRA-PPS-3

	TEFRA		PPS-1		PPS-2		PPS-3	
	Percent of Operating Costs	Percent of Total Costs	Percent of Operating Costs	Percent of Total Costs	Percent of Operating Costs	Percent of Total Costs	Percent of Operating Costs	Percent of Total Costs
Non-System Hospitals:								
Government Hospitals	95%	103%	99%	108%	96%	106%	94%	104%
Other Non-profit Hospitals	100	104	103	108	101	106	100	105
Religious Hospitals	102	106	104	108	101	107	96	101
Investor-Owned Hospitals	98	100	104	105	100	102	94	96
System Hospitals:								
Government Hospitals	93%	100%	96%	105%	93%	103%	91%	100%
Other Non-profit Hospitals	101	105	102	106	99	104	98	102
Religious Hospitals	102	106	104	109	102	107	101	105
Investor-Owned Hospitals	106	106	107	107	104	104	102	103

Source: Merged AHA and MCR data
EXK628102488

The major trends across the four analytic years are that hospitals in all eight ownership/system groups did much better financially in PPS-1 and -2 than in TEFRA but that by the third year, their operating margins were worse than pre-PPS and their total margins were the same or worse for system hospitals while non-system hospitals fell into two camps: those that did only marginally worse in PPS-3 than in TEFRA (government and other non-profits) and those that did markedly worse (religious and investor-owned). The former non-system facilities did better than their affiliated counterparts. For religious and for-profit hospitals, system affiliation was associated with better performance.

3.0 DO HOSPITALS IN MULTIHOSPITAL SYSTEMS HAVE HIGHER COSTS?

Are there cost and productivity differentials between multihospital systems (MHS) and independent hospitals? Coyne (1982) concluded that religious, other non-profit, and investor-owned system hospitals are more costly than independent ones holding a number of variables, including length-of-stay, constant. Levitz and Brooke (1985) also found system hospitals to incur higher costs but attributed them to longer lengths of stay. They also found system hospitals to be characterized by higher labor productivity and fewer administrators per output unit. The authors stated that the latter helped in achieving economies of scale, Renn, et al., (1985) reached the opposite conclusion, however, that there are no major differences between hospitals with respect to system affiliation. Significant differences in costs arise from ownership instead.

These other studies, however, have analyzed very small samples and most have not controlled for wage or casemix among systems. The analyses in this chapter hold important factors such as casemix and output measures constant. This study also differs from other studies in that all acute-care hospitals with Cost Reports in non-waivered states except Alaska and Hawaii are included. Therefore, the sample, is larger than in previous studies. The next section discusses the characteristics of a cost function and the subsequent section discusses empirical results.

3.1 Specifying an Economic Model of Total Hospital Costs

To test whether system hospitals were more costly than their independent counterparts prior to PPS and whether prospective payment altered any existing cost relationships, we estimated several multivariate regressions of average cost per case under TEFRA and PPS-3, holding constant hospital, area, and system characteristics. In each case the basic null hypothesis was that the average cost per case in system hospitals would not be statistically different from that in the appropriate control group.

The basic reduced-form behavioral cost equation relates hospitals' average cost per case to exogenous factors reflecting relative input prices and the mix of products associated with each facility. The specification used was:

$$AC = Ae^{(\Sigma\alpha_i S_i)} . e^{(\Sigma_j B_j Y_j h)} . W_1^S . X_j^\gamma . B_h^\theta . e^{\mu h} \qquad (3\text{-}1)$$

where S_i are 0,1 dummies for membership in multihospital systems with different ownership categories (for-profit, religious, etc.); W_1 =

aggregated hourly labor costs for each hospital's HCFA-defined labor market area; X_j = a vector of hospital-specific measures of the mix of cases treated and other activities; Y_{jh} = a vector of hospital characteristics representing unexplained geographic cost differences, if they exist; B = the number of staffed beds; and μ = a residual error term.

Taking the natural logarithms of both sides of equation 3-1 gives a specification estimable by ordinary least squares:

$$\ln AC = \ln A + \Sigma_i \alpha_i S_i + \Sigma_j B_j Y_{jh} + \varsigma \ln W_l + \Sigma_j \gamma_j X_{jh} + \theta \ln B_h + \mu_h \qquad (3\text{-}2)$$

The coefficients α_i form the test that the costs of system hospitals in various ownership categories are higher than those in the comparison category; thus, the expectation is that the $S_i = 0$ relative to the intercept: system and non-system hospitals in all ownership categories are the same.

Equation (3-2) recognizes that hospitals are multiproduct firms: inpatient cases are not homogeneous with respect either to diagnoses or treatment; outpatient cases, teaching and other activities also represent products that could raise costs. To solve this problem, we control for the X_j products. One way is to use an index that aggregates across weighted combinations of diagnoses. If this were available across all inpatient cases, one aspect of the multiproduct nature of hospitals could be entered in (3-2). Lacking that, we control for the mix of Medicare cases through the Medicare casemix index. This is believed to be highly correlated with the severity of non-Medicare cases.

Other hospital outputs include outpatient visits, which are as varied as well-baby clinic visits and urgent care in the emergency room. Ideally, a measure to control for the mix of these service products should also be controlled for in (3-2). However, we are able to control only for scale effects through the total number of visits. Medical residents are a recognized product of hospitals with teaching programs. Medical training requires costly effort and inputs by hospital staff, although the labor of the residents themselves may lead to overall savings, in theory. This output is held constant through the size of the residency program (residents per bed).

The only measure of factor prices available for this model is the HCFA wage index of hourly aggregate wages in 1982. If wages in one area are higher than in another, costs will be higher. Other research has shown that this variable is highly significant in explaining hospital costs, perhaps capturing the effects of other relative prices, as well.

The quantity of inpatient care is measured by the hospital's bedsize combined with the occupancy rate. Greater bedsize may lead to higher costs because it increases the size of the staff and other inputs required to operate the hospital. Higher occupancy should lower average costs through some threshold reached because staff and equipment can be used more efficiently above some minimum staffing.

The datasets are described in Appendix A. The units of observation are the hospitals in the non-waivered states. A file of 4600 hospitals in the non-waivered states was used to test the hypotheses concerning systems in TEFRA. Additional cross-sectional cost functions were estimated for TEFRA and PPS-3 on a smaller file of hospitals with both years of data to estimate the effect of prospective payment on hospitals' costs indirectly. Other changes in this period, such as increased utilization review by HMOs or private insurers, are not held constant, however.

An additional specification problem was the identification of the correct comparison group for the system hospitals. To enter a single dummy variable for all system hospitals would compare mean costs for all system hospitals with the mean for all non-system hospitals. Because government-owned hospitals tend to be lower in cost than other hospitals and for-profit facilities tend to be higher, a difference in the mix of ownership types among system versus non-system hospitals could make it seem that a difference in costs was due to the system when it should be associated with the ownership categories.

Coyne (1982) found significant cost differences between system and non-system hospitals within four ownership categories. Renn, et al., (1985) found greater similarities among hospitals of the same ownership types than among system or free-standing facilities. Our study controls for this mix of ownership and system membership through complementary regressions. One set of regressions interacts system membership and ownership while another set tests for the significance of system membership within each of the four ownership category. Additional regressions testing for the effects of geographic dispersion and owning versus managing on hospital costs, will be included in the Final Report.

3.2 Empirical Results

This section presents econometric estimates to address two separate questions. The first is whether hospitals in multihospital systems are more costly per case than their freestanding counterparts. The second is whether the relationship between system affiliation and costs was affected by prospective payment. The first of these is addressed in subsection 3.2.1, percent for every percent increase in the occupancy rate). These results are in keeping with prior expectations.

using merged AHA and Medicare Cost Report data on 3,421 short-term, acute-care hospitals for their TEFRA fiscal years. The latter question is answered in 3.2.2 using a subset of the datafile with 1,933 hospitals for which both TEFRA and PPS-3 fiscal year financial reports were available. Both files include only hospitals in all of the non-waivered states. Variable definitions and logarithmic mean values are presented in Table 3-1 and 3-3, respectively.

3.2.1 Are Hospitals in Systems More Costly Per Case?

Our multivariate regressions, based on equation 3-2 above, confirms the general finding of Renn, et al., (1985) that ownership type is more important than system affiliation in explaining differences in costs across hospitals. An exception is government-owned hospitals (not studied as a separate group by Renn, et al.) for which system affiliation is associated with being more costly per case.

Table 3-2 presents the estimates for a regression of the natural log of average total costs in hospitals' TEFRA years on system affiliation interacted with ownership and holding constant cost factors such as casemix, wages, bedsize, teaching activities, and region. The variables interacting system affiliation and ownership test for significant cost differentials among types of hospitals. All of these hospitals are compared to freestanding, government-owned hospitals, the omitted category.

All other groups of hospitals are more costly, on average, than independent, government hospitals. Government system hospitals are seven percent more costly than independent ones. This difference is highly significant. For-profit hospitals are 13 to 17 percent more costly, depending on their system affiliation; religious hospitals are six to eight percent more costly; and other not for profit hospitals are four to seven percent higher in cost, holding relative wages, casemix, etc., constant.* These differences are all significant at the one percent level.

Almost all of the other independent variables are highly significant. The F-ratio of 250 indicates that, as a group, they are important explainors of average total cost, accounting for 57 percent of the variation in average cost. One of the largest coefficients is for the relative wage index. An increase in the wage index of one percent is associated with a cost increase of 1.02 percent. The occupancy rate and the hospital's bedsize control for the quantity of cases produced. They indicate that costs rise with the number of beds (by 0.04 percent) but fall with increasing occupancy (a fifth of one

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*Researchers generally interpret dummy variable coefficients in semilogarithmic equations as arithmetic percentage differences. Halvoren and Palmquist (1980), however, demonstrate a bias using the unadjusted coefficients, which increases with the size of the difference. In fact, each coefficient (a) is an estimate of $a = \ln(1+g)$ where $100g$ is the correct percentage differences. Exponentiating and solving for g gives $g = [\exp(a)-1]$. For $a = .05$, $g = .0513$, a trivial difference, whereas for $a = .50$, $g = .649$. All dummy coefficients discussed in the text are therefore transformed into simple arithmetic differences using $g = [\exp(a) - 1]$.

TABLE 3-1

VARIABLE DEFINITIONS AND LOGARITHMIC MEANS, TEFRA

		TEFRA	
		Mean	Std.Dev.
Average Cost per Case		7.73	0.37
WAGE	= 1982 Relative Wage	-0.07	0.15
OCC RATE	= Occupancy Rate	-0.61	0.36
TOUT	= Total Outpatient Visits	6.99	1.27
CMI	= Medicare Casemix Index	0.007	0.10
RESPERBED	= Residents/Beds	0.01	0.05
BEDS	= Acute-care Beds	4.57	0.94
URBAN	= Location in MSA	0.45	
REGNC	= North Central Region	0.38	
REGS	= South	0.42	
REGW	= West	0.14	
SYSPROF	= For-profit System	0.10	
SYSNFP	= Not-for-profit System	0.08	
SYSREL	= Religious System	0.07	
SYSGOV	= Government System	0.05	
NSYSPROF	= For-profit Non-system	0.03	
NSYSNFP	= Not-for-profit Non-system	0.34	
NSYSREL	= Religious Non-system	0.03	
INFL	= Fiscal Year in Later Half	0.42	

Source: Merged Medicare Cost Report and AHA Annual Survey data.
EXK584/101688

TABLE 3-2

REGRESSION RESULTS: AVERAGE TOTAL COST BY SYSTEM MEMBERSHIP AND HOSPITAL OWNERSHIP, TEFRA AND PPS3[a]

VARIABLE	TEFRA
INTERCEPT	7.24***
SYSGOV[b]	0.07***
SYSPROF[b]	0.16***
NSYSPROF[b]	0.12***
SYSREL[b]	0.08***
NSYSREL[b]	0.06***
SYSNFP[b]	0.07***
NSYSNFP[b]	0.04***
WAGE	1.12***
OCC RATE	-0.21***
TOUT	0.03***
CMI	0.79***
RESPERBED	1.26***
BEDS	0.04***
URBAN[b]	0.01
REGNC[b]	-0.03*
REGS[b]	-0.07***
REGW[b]	-0.10***
INFL	0.04***
R-SQUARE	.57
F-RATIO	249.53
DEGREES OF FREEDOM	3420

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*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

[a] Dependent variable is the log of average cost per case.
[b] These variables are not in log form.

Source: Merged Medicare Cost Report and AHA Annual Survey data. EXK584/101688.

TABLE 3-3

REGRESSIONS OF COST PER CASE BY OWNERSHIP TYPE

	GOVERNMENT	RELIGIOUS	OTHER NON-PROFIT	FOR-PROFIT
	TEFRA	TEFRA	TEFRA	TEFRA
INTERCEPT	7.46***	7.26***	7.29***	7.13***
SYSTEM[a]	0.07***	b	0.03	0.01
WAGE	1.08***	1.10***	1.25***	0.94***
OCC RATE	-0.28***	-0.04	-0.18***	-0.15***
TOUT	0.06***	0.02	0.04***	-0.03*
CMI	0.94***	0.54***	0.78***	0.74***
RESPERBED	1.15***	0.87***	1.33***	4.02***
BEDS	-0.02	0.07***	0.03**	0.13***
URBAN	0.02	-0.02	-0.02	0.05
REGNC	-0.27***	0.02	-0.02	0.12
REGS	-0.34***	b	b	0.12
REGW	-0.34***	0.03	-0.10***	0.11
INFL	0.01	0.06***	0.06***	0.04*
R-SQUARE	0.52	0.63	0.56	0.48
F-RATIO	100.34	48.31	155.26	34.43
DEGREES OF FREEDOM	1145	355	1452	465

[a] Represents hospitals of each ownership type that are in multihospital systems. Nonsystem hospitals are in the intercept.

[b] Less than 0.005.

Source: Merged Medicare Cost Reports and AHA Annual Survey data.
EXK586/101688

Outpatient activity also increases average inpatient costs, by a small but statistically significant 0.03 percent for every percentage increase in outpatient volumes. Increased teaching activity, measured by the number of residents per bed, increases average total inpatient cost by 1.26 percent for each one percent increase, *ceteris paribus*.

In this specification, hospitals in metropolitan areas are not significantly more costly than rural hospitals when system affiliation, ownership, casemix, etc., are held constant in TEFRA. Hospitals in the other three Census regions are significantly less costly than those in the Northeast. The three percent cost differential of the North Central states is significant at the ten percent level, while the seven to ten percent lower costs in the South and West are highly statistically significant.

Finally, to control for the fact that the hospitals' TEFRA years could begin as much as 11.9 months apart, a variable to capture the inflation occurring between the first and second halves of the time period (INFL) indicates that facilities that started their TEFRA years in the second half were four percent more costly, on average, than those with fiscal years beginning between October, 1982, and April, 1983.

Table 3-2 indicates that system is important in explaining the average costs of government hospitals and also seems to suggest that costs differ more by ownership category than by system affiliation. However, are the differences between system and non-system hospitals in each ownership category statistically significant? This is addressed through separate regressions for each of the four ownership categories, as presented in Table 3-3.

These four separate regressions include the same explanatory variables as in the model in Table 3-2. The basic findings are that government hospitals in systems are a highly significant seven percent more costly per case than independent government hospitals (column 1) and other non-profit facilities are three percent more costly if they are in a system than when they are not. The differences in costs for the other two ownership categories are not statistically significant. The coefficient estimates are sensitive to the specification of the regression model, however.

3.2.2 Did the Relationship of System Affiliation and Costs Change After PPS?

In this section, the question of whether the correlation between ownership, system affiliation and average total inpatient costs changed between TEFRA and the third year of PPS (the most recent available at this writing) is answered in the negative, at least for the sample analyzed here. The dataset contained only hospitals with both TEFRA and PPS-3 data and thus had considerably fewer observations than did the file used for section 3.2.1 analyses. Table 3-4 presents the mean values for both TEFRA and PPS-3 for

LE 3-4

ARIABLE DEFINITIONS AND LOGARITHMIC MEANS, TEFRA, PPS-1

		TEFRA		PPS-1	
		Mean	Std.Dev.	Mean	Std.Dev.
Average Cost per Case		7.68	0.36	8.01	0.37
WAGE	= 1982 Relative Wage	-0.08	0.14	-0.08	0.14
OCC RATE	= Occupancy Rate	-0.60	0.34	-0.89	0.45
TOUT	= Total Outpatient Visits	6.95	1.23	7.11	1.23
CMI	= Medicare Casemix Index	a	0.09	0.10	0.12
RESPERBED	= Residents/Beds	0.01	0.04	0.01	0.04
BEDS	= Acute-care Beds	4.55	0.91	4.50	0.90
URBAN	= Location in MSA	0.44		0.44	
REGNC	= North Central Region	0.37		0.37	
REGS	= South	0.48		0.48	
W	= West	0.12		0.12	
SYSPROF	= For-profit System	0.11		0.12	
SYSNFP	= Not-for-profit System	0.08		0.12	
SYSREL	= Religious System	0.06		0.06	
SYSGOV	= Government System	0.04		0.05	
NSYSPROF	= For-profit Non-system	0.03		0.03	
NSYSNFP	= Not-for-profit Non-system	0.35		0.33	
NSYSREL	= Religious Non-system	0.02		0.02	

[a] Less than 0.005.

Source: Merged Medicare Cost Report and AHA Annual Survey data.
EXK584/101688

TABLE 3-5

REGRESSION RESULTS: AVERAGE TOTAL COST BY SYSTEM MEMBERSHIP AND HOSPITAL OWNERSHIP, TEFRA AND PPS3[a]

VARIABLE	TEFRA	PPS3
INTERCEPT	7.27***	7.69***
SYSGOV[b]	0.03	0.05*
SYSPROF[b]	0.19***	0.21***
NSYSPROF[b]	0.18***	0.18***
SYSREL[b]	0.08***	0.08***
NSYSREL[b]	0.07*	0.11***
SYSNFP[b]	0.08***	0.07***
NSYSNFP[b]	0.02*	0.03**
WAGE	1.02***	0.87***
OCC RATE	-0.23***	-0.22***
TOUT	0.04***	0.02**
CMI	0.85***	0.83***
RESPERBED	1.04***	1.22***
BEDS	0.04***	c
URBAN[b]	0.01	0.07***
REGNC[b]	-0.11***	-0.08**
REGS[b]	-0.15***	-0.15***
REGW[b]	-0.19***	-0.13***
INFL	0.07***	0.06***
R-SQUARE	.55	.48
F-RATIO	138.22	104.32
DEGREES OF FREEDOM	1932	1932

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*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

[a] Dependent variable is the log of average cost per case.
[b] These variables are not in log form.
[c] Less than 0.005.

Source: Merged Medicare Cost Report and AHA Annual Survey data. EXK584/101688.

this dataset. Biases in the sample are discussed in Appendix A. Because this restricted dataset contains fewer teaching and for-profit facilities, which tend to be more costly, the conclusion that prospective payment did not affect the relationship of costs to system affiliation may not be generalized to the nation as a whole. This hypothesis will require investigation in the future.

Table 3-5 presents the results of the basic estimations for TEFRA and the first year of PPS. System membership is interacted with the hospitals' ownership to test for both effects on costs at the same time, holding other factors, such as relative wages, occupancy, and bedsize, constant. The omitted category is that of independent government hospitals. In TEFRA, government hospitals in systems were not significantly more costly per case than those that were freestanding. In contrast, for-profit hospitals were 20 and 21 percent more costly (than independent government hospitals) whether they were freestanding or in a system, respectively. A separate test of the significance of these coefficients (presented in Table 3-6, Column 7) shows that they are not statistically different from one another at the 10 percent confidence level.

Church-owned hospitals, whether in a system or not, were seven to eight percent more costly than independent government hospitals. These were significant at the one percent and ten percent confidence level, respectively. However, they were not significantly different from each other. Other non-profit hospitals were eight percent more costly than free-standing government hospitals if they were in a multihospital system but only two percent more if they were independent hospitals. These coefficients were statistically different from the comparison group at the one and ten percent confidence levels, respectively, and differed from each other at the five percent level.

Of the other explanatory variables, all but one were highly significant. Wages had a large effect on average costs, with the coefficient of 1.02 indicating a roughly one-for-one increase in costs for every additional percent increase in the relative wage index. An increase in hospitals' occupancy rates was associated with a decrease in average costs of about a quarter as much. That is, for each ten percent increase in a hospital's occupancy, one would expect average costs to drop by about 2.3 percent. Increased outpatient activity, on the other hand, leads to an increase in average cost of .04 as much.

The index of Medicare casemix complexity, proxying for the level of severity in all inpatient cases, is associated with a highly significant 85 percent increase in average costs. The measure of teaching activity, the number of medical residents per bed, also has a positive and significant impact on costs. Increased bedsize leads to a small but very significant increase in average costs. However, location in an MSA does not lead to significantly higher costs. The variables for regional location are all negative and highly significant, however. All three Census regions are less costly than the Northeast, the excluded region. The reductions range from twelve to twenty percent.

The R-square for this regression is 0.55, indicating that these factors explain 55 percent of the variation in average total cost per case. The F-ratio of 138 shows that these variables together are highly significant explanatory factors, as well.

The second column in Table 3-5 presents the regression explaining costs in the third year of PPS. With respect to the differences in costs among groups of system and non-system hospitals, little changed in those three years. Government-owned hospitals in systems remained insignificantly more costly than their independent counterparts, the excluded category. For profit hospitals were 20 to 23 percent more costly, whether outside or in a system, respectively. The difference between the two types of for-profit facilities was not statistically significant, however, as shown in Table 3-3. Religiously affiliated hospitals were eight to twelve percent more costly than the comparison group but the difference between those in and not in multihospital systems was not statistically significant at even the ten percent confidence level.

Other not-for-profit hospitals were also three to seven percent more costly than non-system government hospitals. These differences are significant at the ten and one percent confidence levels, respectively. However, they are not statistically different from one another, as shown in Table 3-6, column 6. This is a small change from the TEFRA costs regression which indicated that other system not-for-profit hospitals were slightly more costly than those not in systems.

The relative importance of most of the other explanatory cost factors was unchanged between TEFRA and PPS-1. The size of the coefficient for WAGE, based on 1982 data, decreased. The coefficients for teaching and urban location increased, however. The diseconomy of scale indicated in the TEFRA regression by the highly significant and positive coefficient on the BEDS variable has disappeared in PPS-1. The other three Census regions are still significantly less costly per case than hospitals in the Northeast but the spread between the regions compressed somewhat. Under TEFRA, there was a 21 percent spread between the costs in the Northeast and the least costly region, the West. In PPS-3, the difference was only 16 percent, with the South being the least costly region, ceteris paribus.

The independent variables do not do as well in explaining costs in PPS-3 as in TEFRA. The R-square is only 0.48, a slight fall in the percentage of

TABLE 3-6

REGRESSIONS OF COST PER CASE BY OWNERSHIP TYPE

	GOVERNMENT		RELIGIOUS		OTHER NON-PROFIT		FOR-PROFIT	
	TEFRA	PPS-1	TEFRA	PPS-1	TEFRA	PPS-1	TEFRA	PPS-1
INTERCEPT	7.34***	7.84***	7.25***	7.54***	7.32***	7.81***	7.09***	7.49***
SYSTEM[a]	0.02	0.03	-0.01	-0.05	0.05**	0.03*	-0.01	0.02
WAGE	0.86***	0.68***	0.83***	0.50**	1.17***	1.14***	0.74***	0.42*
OCC RATE	-0.29***	-0.29***	-0.03	-0.09	-0.19***	-0.17***	-0.16***	-0.23***
TOUT	0.09***	0.07***	0.03	0.01	0.04***	0.01	-0.02	-0.02
CMI	1.00***	0.90***	0.56**	0.55***	0.89***	0.92***	0.67***	0.72***
RESPERBED	0.67***	0.77**	0.76	1.09**	1.15***	1.36***	3.63***	3.28**
BEDS	-0.01	-0.07**	0.06*	0.03	0.03	b	0.12***	0.06*
URBAN	-0.02	0.07	0.03	0.13**	-0.02	0.01	0.11*	0.22***
REGNC	-0.34***	-0.38**	0.02	0.15	-0.08*	-0.07*	0.17	0.25
REGS	-0.42***	0.50***	-0.05	0.03	-0.08*	-0.07	0.13	0.09
REGW	-0.42***	-0.37**	0.05	0.17	-0.21***	-0.16***	0.19	0.18
INFL	0.09**	0.11**	0.07	0.16***	0.09***	0.07**	0.03	0.02
R-SQUARE	.49	.40	.67	.57	.51	.48	.50	.44
F-RATIO	51.92	32.46	25.18	15.91	70.40	64.91	21.00	20.70
DEGREES OF FREEDOM	672	605	164	155	827	872	266	297

[a] Represents hospitals of each ownership type that are in multihospital systems. Nonsystem hospitals are in the intercept.

[b] Less than 0.005.

Source: Merged Medicare Cost Reports and AHA Annual Survey data.
EXK586/101688

the variance explained. The F-ratio is still very significant, however.

Our analysis confirms the conclusions of Renn, _et al_., (1985) that hospital ownership is a more significant explanation of cost differences than is affiliation with a multihospital system. Further, this was basically unchanged by the third year of prospective payment. In fact, the relative differences in costs between the groups of hospitals, defined by system affiliation and ownership remained basically unchanged between TEFRA and PPS-3.

3.2.3 Future Analyses

This analysis remains preliminary as of this writing. Major questions whether characteristics of the systems themselves, such as their geographic dispersion, the number of hospitals and beds controlled, or the number of years since a hospital joined, explain the patterns of costs need to be addressed. The relationships of costs to cost components such as lengths of stay, productivity, and financing costs remain to be explored. These are very important to an understanding of differences among the various segments of the industry, particularly differences between tax-exempt institutions and for-profit ones which must raise financial capital in the open market.

REFERENCES

Alexander, Jeffrey, et al., "Acquisition Strategies of Multihospital Systems," Health Affairs 4:3 (Fall 1985).

Alexander, Jeffrey et al., "The Financial Characteristics of Hospitals Under For-profit and Non-profit Contract Management, " Inquiry 21:230-42 (Fall 1984).

American Hospital Association. Guide to The Health Care Field, 1988 Edition, AHA, Chicago, IL.

Cooney, J. and Alexander T., Multihospital Systems, Health Services Research Center of the Hospital Research and Education Trust and Northwestern University, 1975, Part 3 (Volume 3), 195-203.

Coyne, Joseph. "Assessing the Financial Characteristics of Multi-Institutional Organizations," Health Services Research 19:6 (February 1985, Part I).

Coyne, Joseph. "Hospital Performance in Multihospital Systems: A Comparative Study of System and Independent Hospitals," Health Services Research 17:4 (Winter 1982).

Ferber, B., "An Analysis of Chain-Operated for-profit Hospitals," Health Services Research 6:49-60 (Spring 1971).

Halvorsen, R., and R. Palmquist, The Interpretation of Dummy Variables in Semi-logarithmic Equations, American Economic Review 70, 1980: 474.

Kralewski, John et al., "Effects of Contract Management on Hospital Performance," Health Services Research 19:4 (October 1984).

Levitz, Gary S. and Brooke, Paul. "Independent Versus System-Affiliated Hospitals: A Comparative Analysis of Financial Performance, Cost, and Productivity," Health Services Research 20:3 (August 1985).

Lewin, L. et al., "Investor-owned and Non-profits Differ in Economic Performance," Hospitals J.A.H.A. 55:52-58, July 14, 1981.

McCue, Michael J. and Richard W. Furst. "Financial Characteristics of Hospitals Purchased by Investor-Owned Chains," Health Services Research 21:4 (October 1986).

Mullner, Ross et al., "Interstate Variations in the Growth of Chain-Owned Proprietary Hospitals, 1973-82," Inquiry 21:144-51 (Summer 1984).

Renn, Steven et al., "The Effects of Ownership and System Affiliation on the Economic Performance of Hospitals, Inquiry 22:219-236 (Fall 1985).

Warner, Michael et al., "A Strategic Planning Model for Multihospital Systems," Inquiry 18:214-23 (Fall 1981).

Wheeler, John et al., "How Management Contracts Can Affect Hospital Finances," Inquiry 19:160-66 (Summer 1982).

APPENDIX A: DATA AND FILE CONSTRUCTION

Three databases were used for this report on multihospital systems. The first was a dataset of all non-federal, acute-care hospitals in the United States existing between 1980 and 1986. For this, records were merged from three sources to obtain the universe of the acute-care hospital industry. The second was a merged file of Medicare Cost Reports and data from the American Hospital Association (AHA) annual surveys. Hospitals' fiscal years covered by the regulations under TEFRA and the first three years of the prospective payment system were included in this file. A third file containing information from the 1988 AHA Guide on multihospital systems that existed in 1987 was constructed and merged to both the first and second data files. The universe file is discussed in A.1 while the analytic file for TEFRA through PPS-3 is described in A.2. Possible biases in the analytic file for TEFRA-PPS-3 are discussed in A.3. The systems datafile is the subject of A.4.

A.1 The Universe File

A.1.1 Data Sources

Hospital records were obtained from three sources: the AHA annual surveys, Medicare Cost Reports (HCRIS) and HCFA's Provider of Service (POS) file. These three databases included any available information on the hospital's name, the unique AHA hospital identification code (hospid), location, ownership, personnel, utilization, reporting procedures, expenses, admissions, number and type of beds, length of stay, Medicare participation, HMO participation, and affiliations. From the Area Resource File (ARF), the final database also included some demographic information on the population of the county in which each hospital was located. The universe file consists of 38,580 hospital-level records sorted by state, hospid and year. It includes information on the AHA hospid, the hospital's name and location, the year of the record, the source of the record, the AHA control and service codes, a code for the type of facility as listed on the POS, and up to three estimates of each hospital's bedsize (one from each source).

A.1.2 Problems Defining the Universe File

The universe file presented a few problems. Some of the hospitals on the file had never been acute-care facilities. Other hospitals did not have records for all the years 1980-1986. In addition, some of the records lacked hospids. Each of these problems was solved as follows.

A.1.2.1 Cleaning The File of Federal and Exempt Records

To clean the database of any records for federal hospitals, we moved hospitals with federal control codes (1,755 records) to a separate file. Nine U.S. public service hospital records were also added to this file, for a total of 1,764 records.

Non-acute-care hospital records were placed in one of two files, depending on the number of years of data on file. An exempt facility file, including any hospitals with a full six years of data that did not fit our acute-care definition, was created. These non-acute-care records included records for nursing homes and chemical dependency, substance abuse, long-term care, or psychiatric units. The second file included sequences of records for any non-acute-care hospitals included in the original file that did not have a full six years of data.

When there were more than six years of records for a hospital, the hospitals were contacted by telephone to find the reasons for the redundancies. In the majority of cases the excess records represented exempt units of acute-care facilities. These records were added to the appropriate exempt file and deleted from the universe file.

A.1.2.2 No Hospid

There were 2,662 records without AHA hospids. Each record was assigned a sequence number for identification. These records were manually matched by name, FIPS county code, and bedsize with records in the same state that had an identification code. We were also able to assign a few hospids from an internal HER file which listed hospitals by state and hospid. Some hospitals could not be matched because of name changes. These were resolved using two types of sources: the AHA guides (1978, 1982, 1984 and 1986) and the provider of service (POS) file from HCFA.

Through these methods, we were able to assign identification codes to 2,028 records that had been missing then. An additional five records were United States service hospitals and were placed on the federal file. The 629 records that still lacked hospids were given internal HER reference numbers.

To provide more information on the hospitals given HER reference numbers, we did extensive phone calling. Calls were made to state and local hospital associations, and to state licensure bodies. This helped us determine whether hospitals had opened or closed, merged, or changed in some other way that affected their identification.

A.1.2.3 Missing Data

Compiling a complete computer file of acute-care, general hospitals was only the first step in the construction of the analytic file. Equally important for any study of the industry's structure, was ensuring complete data for the 1980 through 1986 period. Some hospitals were missing important information for a few items; others lacked records for one or more entire years. These problems were resolved using various sources of information.

Padding Records for Missing Years

Some hospitals had incomplete sequences for the last years of the 1980-1985 period. If the hospital was open in 1986 according to the AHA survey data for that year, we assumed it had also been open during the intervening years. We padded the missing records with information from the last available year on file.

Hospitals that were complete except for 1980, 1981, or 1982 were checked against the AHA guides to see if they had been open prior to 1980. If the 1978 AHA guide showed that they were in business, we padded any years that were missing with information from the first year we had on file. The hospitals that did not show up in the AHA guides for the years in question were checked against the POS file to find their effective date for Medicare coverage. When the effective date was prior to the period in question, we assumed the hospital had been open, and we padded the missing years with information from the first available year on the file.

To clarify the status of the remaining incomplete sequences, we called state licensure agencies and a few state and local hospital associations. In the rare event when we were unable to obtain any information through this method, we contacted the hospital directly. We flagged the records of all the hospitals that had opened, closed, or merged, in the 1980-1986 period.

Control and Service Codes

Though our universe file consisted of complete six year records, some lacked important information, such as the hospital's service and control code, because we had no AHA entry for that hospital. Therefore, we generated a list of records lacking either of these codes. By referring to the AHA guides (1978, 1980, 1982, 1986), we were able to pad these records with the codes they were missing. When the AHA did not list the hospital in question, we called state and local hospital associations, and state licensure agencies to obtain the needed information.

A.1.3 Bedsize Variables

Another problem with the universe file was that some of the bedsize numbers for the hospitals were questionable. As previously mentioned, we had three sources of bed size information: POS, HCRIS, and the AHA. Unfortunately, the POS's definition of a bed differs from the definition used by the AHA and HCRIS. The POS bed numbers reflect licensed beds and HCRIS's and the AHA's bed numbers represent staffed beds. Therefore, we constructed two variables, one for licensed beds and one for staffed beds. Though we had more complete information for licensed beds, we gave staffed beds priority in terms of defining bedsize. The reason for this choice was that staffed beds are a much more accurate indicator of the true bedsize of hospitals. Only when a hospital record lacked both HCRIS and AHA bed information did we rely on the POS licensed bed numbers.

To check potential discrepancies in bed sizes for individual hospitals throughout the 1980-1986 period, we created two lists from the universe file. The first contained hospitals whose bedsize between any two years in the period had changed by 33 percent or by more than 25 beds. The second list contained any hospitals where the source had changed at least once, and the bedsize had increased or decreased.

For both lists the hospital bed numbers were compared to those listed in the AHA guides (1978,1982,1984,1986). If the fluctuations in bed numbers listed in the file paralleled fluctuations noted in the AHA, the bed numbers were left unchanged. If the bed number sequences listed on the file differed greatly from the AHA bed number sequences, we made an assumption about which numbers were more accurate, or we phoned the state boards of licensure to clarify which numbers were more correct. In a few instances, the hospitals were found to be exempt throughout the period in question.

A.1.4 Hospital Units

As previously mentioned, we obtained data from three sources: HCFA, POS, and the AHA. All three sources report information for different segments of the health care industry, though some of their reporting overlaps. They all organize their reporting by designating numbers to the smallest entities they are concerned with. For instance, HCFA reports on acute-care Medicare certified units and designates a number for each unit. They include acute-care units within institutions such as prisons and schools. The POS, unlike HCFA, not only reports on acute-care entities, it reports on all acute-care and non-acute-care providers of service, from clinics to hospitals; each of these providers is given a POS number. Though the AHA also reports on both acute-care and non-acute-care facilities, in contrast to HCFA and the POS, the AHA only reports information on hospitals. They sometimes designate one number for a related group of hospitals. For instance, if an urban hospital has a satellite branch in a local suburb, the AHA may give the same number to both hospitals.

Unlike HCFA, we did not include acute-care units housed within an institution such as a prison, school or mental hospital within our database. We chose to omit this type of acute-care unit from our definition of an acute-care hospital because it does not provide acute-care services to the general public; care is only administered to institution inmates. Unlike the POS, we did not include clinics or non-acute-care facilities within our database. Similar to the AHA our database is made up solely of hospitals, though unlike the AHA we limit our reporting to acute-care hospitals. In contrast to the AHA we tried to list each hospital individually, rather than reporting on groups of affiliated hospitals.

In defining a hospital unit we concentrated on units within acute-care hospitals. For this study we define hospital units as those units in an acute-care hospital that do not offer acute-care services. Unlike the parent acute-care hospital, the exempt units are not covered under PPS. These exempt units provide such services as: long-term care, alcohol and chemical dependency programs, psychiatric services etc. In cleaning our acute-care hospitals' bed information, we omitted exempt unit beds whenever possible. We used the American Hospital Association (AHA) Guides (1978-1986) as a basis for determining whether an acute-care hospital housed an exempt unit. The AHA noted nursing home, alcohol and chemical dependency rehabilitation, and psychiatric beds for its registered hospitals. Thus we were able to subtract these beds from the total to obtain the acute-care beds. For those hospitals not registered with the AHA, but included in the AHA Guides, no information was given on exempt units. Therefore we were unable to discern whether these hospitals housed exempt units and hence could not correct their beds.

A.1.5 Acute-Care

In this study we define acute-care as short-term care which includes general medical and surgical services or some other select specialty services. As defined by the American Hospital Association (AHA), short-term signifies that the "average length of stay for all patients is less than 30 days or over 50% of all patients are admitted to units where average length of stay is less than 30 days." Included within our definition of select specialty services are: obstetrics and gynecology; eye, ear, nose and throat; and orthopedic. Also, we included services defined by the AHA "as other specialties" (e.g., arthritis, proctology and geriatrics etc). Many hospitals defined as offering these other specialties also have general medical and surgical units.

Our definition of acute-care does not include specialties such as: psychiatric services, alcohol and chemical dependency services, tuberculosis and other respiratory disease services, rehabilitation services, childrens' services, mental retardation services, and chronic disease services. In addition, acute-care does not include general medical and surgical services available in institutions such as prisons, schools or facilities for the mentally retarded.

A.2 The PPS Analytic File

The file of merged Medicare cost reports and AHA survey data was obtained frm Abt Associates, Inc., as part of HCFA contract No. 500-85-0015. Its construction involved a great deal of computer processing.

A.2.1 Summary of HCRIS Data Processing

Tests for duplicate cost reports were conducted on all files. Duplicate reports had the same provider identification code, cost report beginning and end dates, and status. Cost report records identified as duplicates were manually reviewed to determine consistency of data, presence of key variables and worksheets, and general data availability. The record fulfilling the greater part of these criteria (i.e., the "best" record) was selected for each provider and the other was deleted from the file. In a few cases on the cost reports, it was impossible to choose a cost report according to the above criteria, and one of the duplicate reports was selected randomly. The TEFRA duplicates were found to have identical data.

Because the PPS master file contained multiple cost reports for the same provider and reporting dates, it was necessary to select the "best" of these multiple reports as indicated by the status code. A total of 2,138 reports having identical ID numbers and reporting dates but lesser status were deleted from the file (e.g., any "audited" report was selected over any "as submitted"). In addition, 163 cases with all data missing were deleted from the PPS1 file and 36 non-U.S. hospitals were deleted overall.

Edit checks on cost report begin-end dates were then conducted to determine and eliminate problem cases. Noted problems included missing or unreadable values, data outside of the fiscal years for the payment systems, and reports with overlapping dates on the longitudinal file. Cases with unreadable values were deleted. Where typographical errors were obvious, corrections were made to the dates. Otherwise, cases where assumptions on dates would have been ambiguous were deleted from the files. Other anomalies such as reports beginning or ending a few days outside of their fiscal year limits or overlapping with reports on other files were documented, but not corrected.

Missing values will be an important issue for analysts since HCFA treated them differently on each of the three files. The TEFRA master file has all zero values coded as missing. The PPS1 file contains both missing values and true zeros.

Since in some years HCFA did not require the submission of all worksheets, tests for the completeness of cost reports were conducted using frequencies for the number of missing worksheets and for specific missing worksheets for all cases. Most of the worksheets on all the files were missing for less than 5 percent of the cases. Problem worksheets on H180 included A-1 (42.8% missing) and G (74.4% missing). The TEFRA worksheets missing for a large percent of the cases was F (84.1% missing). The missing PPS worksheets were A-8 (89.0% missing), A-8-2 (22.9% missing), D-8 (14.8% missing) and F (83.7% missing). Over 50% of the cases in PPS1 were missing two worksheets while over 70% of the TEFRA cases reported one missing worksheet. The majority of the remaining cases reported either one or three missing worksheets.

A.2.2 The Structure of the PPS Analytic File

The analytic file is defined at the hospital level for each period between the hospital's fiscal year covered by TEFRA regulations and that covered by the third year of PPS. Only nonwaivered states are included. Because the hospitals' fiscal years could vary in length, all cost report flow variables, such as discharges, outpatient visits, costs, revenues, etc., were calculated as monthly values averaged across the fiscal year. AHA annual survey data items were also converted to monthly averages (for flow variables such as expenses, admissions, etc.) and matched to each hospital's cost report data according to the dates of the respective reports. Where AHA survey data time periods did not match those of the cost reports, a weighted average of the AHA data items from the two surveys covering the cost report period were matched to the latter.

In addition to these two data sources, hospital-level data items from Medicare's Impact file and county-level data items from the Area Resource File were also merged to the analytic file. Where these items were time dependent, they were matched to the year in which the mid-date of the hospital's Medicare Cost Reports for a given pay system (such as TEFRA or PPS-2) occurred.

A.3 Biased Sample Analysis

For some of the multivariate regressions in this report, it was desirable to restrict them to the set of hospital's with data for all four time periods; TEFRA, and PPS-1 through PPS-3. Further, inclusion of PPS-3 data (for 1985-1986) was felt to be most desirable. The problem is that this reduces the number of hospitals in the PPS analytic file to 3,792 from the almost 4,600 hospitals with data in the TEFRA through PPS-2 time periods.

A biased sample analysis on the four-period file indicates that it underrepresents urban hospitals, particular urban teaching hospitals, compared to a three-period file. Proprietaray hospitals are also underrepresented as are those located in the Pacific, Mid-Atlantic, and South Atlantic Census division. For rural hospitals, the four-period file contains 83-87 percent of the hospitals in the three-period (4,600 hospital) file. The lowest percentage is for hospitals with 50-99 beds reported four periods of data. For analyses restricted to rural hospitals, the 2,047 facilities appear to be fairly representative of those in the nonwaivered states, although for any given data item, the possibility of missing data will greatly affect this.

A.4 Multihospital System File

The multi-hospital system (MHS) file contains data from the 1988 AHA survey on healthcare systems, which includes information on the 302 systems in the United States in 1987. One system that serves only Hawaii is not included. The records in our database consist of the AHA's unique system identification code, the system's ownership type as defined by the AHA, the number of hospitals and beds owned, leased or sponsored by the system, the number of hospitals and beds managed by the system, and the system's market area (e.g., national, regional or local) as determined by inspection of the AHA's listing of the names and addresses of hospitals included in each system.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES-- TRENDS IN CAPITAL COSTS UNDER PROSPECTIVE REIMBURSEMENT

Working Paper

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EXECUTIVE SUMMARY

After the implementation of the Prospective Payment System (PPS), capital was one of the few areas of hospital costs reimbursed by Medicare on a cost basis. Although the capital reimbursement methodology was not changed, PPS may have affected capital costs. This report examines the capital costs of hospitals during the first years of PPS to describe any such effects.

As implemented, PPS might affect investment and, ultimately, capital costs through many channels. First, the combined effect of DRG payments and the continued passthrough of capital costs is believed to have lowered the price of capital relative to other inputs, increasing demand for physical assets. Second, evidence indicates that PPS led to a decline in inpatient volume, lowering the demand for physical assets. Third, hospitals' Medicare profits, widely attributed to PPS's DRGs, may have been spent on new technology to attract physicians and their patients. Fourth, because of uncertainty about how and when capital costs will be integrated into PPS (as mandated in the enabling legislation), it is likely that hospitals tried to change the mix of investments to increase the share in physical assets that can be quickly depreciated. Other factors, unrelated to PPS, may also have affected investment and capital costs during the first few years of PPS.

Some of the factors listed above led to increased demand for capital assets while others decreased it. While unequivocal predictions of the net impact of PPS on the overall demand for physical assets cannot be made, it is likely that the net impact was to increase it. It is also likely that the factors affected both the level and mix of physical capital acquired by hospitals since the implementation of PPS.

This study used data primarily from Medicare Cost Reports (MCRs) in the four Medicare payment periods TEFRA (FY1983) through PPS 3 (FY1986). The file included all non-exempt, nonfederal, short-term, acute-care hospitals (in non-waivered states) for which an MCR was received. Relative to the universe of hospitals, the 3,795 analyzed hospitals under-represented large urban hospitals, major teaching hospitals, and proprietary hospitals. Therefore, capital costs were analyzed by controlling for hospital characteristics. Seven types of capital costs were analyzed as: (1) a dollar level, (2) as a percent of inpatient operating expenses, and (3) per hospital discharge.

Capital costs increased annually over the entire four year period. Mean total capital costs per hospital increased at a compounded average annual rate of 14.5 percent from 1.4 million dollars (TEFRA) to 2.1 million dollars (PPS 3). Total depreciation per hospital increased at an average rate of 12.3 percent from 875 thousand dollars (TEFRA) to 1.3 million dollars (PPS 3). Thus, the combined other components of capital costs (e.g., interest payments, leases on equipment) increased faster than depreciation. The increase in depreciation indicates that capital formation was still continuing during the early years of PPS. The average rate of increase of depreciation on movable equipment exceeded the rate for buildings and fixtures by 2.1 percentage points indicating a change in the mix of physical assets. Medicare's capital costs for inpatients increased at an average rate of 11.9 percent from 498 thousand dollars to 712 thousand dollars per hospital over the four years.

Most of the individual annual increases were greater than ten percent with the increase during PPS 2 the highest for total capital costs. These rates of increase exceeded both the rate of inflation of medical care prices (which in turn was higher than the general rate of inflation) and the rate of increase of expenditures on health services and supplies over this period.

Total capital costs, as a share of inpatient operating expenses, increased from 8.6 percent (TEFRA) to 11.3 percent per hospital (PPS 3). This indicates that capital costs grew faster than inpatient operating costs over this period. Capital costs per discharge increased each year. Total hospital capital costs per discharge increased from $218 (TEFRA) to $406 per hospital (PPS 3). This reflected both the growth of capital costs and the decline in discharges. Total discharges declined by a compounded average annual rate of 4.1 percent while Medicare discharges declined by an average of 5.2 percent.

More than 75 percent of all hospitals had Medicare capital costs less than 1 million dollars during PPS 3. Five percent, however, exceeded 2.6 million dollars. While Medicare capital costs increased each year, there was no change in the concentration of capital costs among hospitals.

Hospitals with more beds had higher Medicare capital costs. While urban hospitals had much higher levels of Medicare capital costs than did rural hospitals, the growth rate of Medicare capital costs in rural hospitals was slightly higher than the growth rate in urban hospitals. Competition is the likely reason that small urban hospitals have higher levels of capital costs than do small rural hospitals. Medicare capital cost levels in state and local government (public) hospitals were considerably lower than in voluntary and proprietary hospitals. While public hospitals had, on average, slightly higher shares of Medicare patients than voluntary or proprietary hospitals, public hospitals typically had only half as many total discharges as voluntary hospitals and about 83 percent of the total for proprietary hospitals.

Medicare capital costs as a share of Medicare inpatient operating costs increased from eight percent during TEFRA to eleven percent during PPS 3. Categories with the highest average growth rates for levels of Medicare capital costs usually had the highest average growth rates for Medicare shares. Urban hospitals usually had higher shares than rural hospitals. Major teaching hospitals had lower shares than large urban hospitals. The likely reason is that while teaching hospitals have very high levels of capital costs, they have even higher labor expenses, suggesting that capital and labor inputs in hospitals tend to be complements instead of substitutes.

Medicare capital costs per Medicare discharge continually increased from $218 per discharge to $390 per discharge. The average growth rate per discharge was much higher than the average growth rate of Medicare capital costs. Medicare capital costs per discharge were 1.8-2 times higher in urban hospitals than in rural hospitals. This can probably be attributed to casemix and competition differences between rural and urban hospitals. Proprietary hospitals had the highest Medicare capital costs per discharge while public hospitals had the lowest. Capital cost per discharge in proprietary hospitals was more than twice as large as that in public hospitals.

A very small number of hospitals had quite large amounts of building depreciation. Even after standardizing building depreciation by operating costs and discharges, urban hospitals had higher levels than did rural hospitals. Rural hospitals, however, had higher growth rates for the share and per discharge values. As would be expected, hospitals with more beds had higher dollar levels of building depreciation. Annual growth rates, while positive, continuously declined at the national level. However, many of the individual categories did not exhibit the same pattern.

After standardizing movable equipment depreciation by operating costs and discharges, urban hospitals had higher levels than did rural hospitals. Rural hospitals, however, had higher growth rates for dollar levels per hospital, the share, and per discharge values. As would be expected, hospitals with more beds had higher dollar levels of movable equipment depreciation. Teaching hospitals had the highest dollar levels of movable equipment depreciation. Non-teaching hospitals, however, had higher average growth rates of movable equipment depreciation than did teaching hospitals.

1.0 INTRODUCTION

One of the few areas of hospital costs still being reimbursed on a cost basis is capital costs. While it has been mandated that capital costs be integrated into the rest of the Prospective Payment System (PPS), there are several areas of uncertainty surrounding its inclusion. First, while inclusion dates have been proposed, there is still uncertainty as to the actual fiscal year in which this will happen. For instance, the final transition to 100 percent national rates for DRGs was postponed one year beyond that originally set. HCFA's suggested final rules for capital costs, effective in FY1987, were not implemented. Congress has mandated that capital costs be treated on a cost basis until FY1992 (ProPAC, March 1988). Second, after an initial date has been finalized for treating capital costs on prospective basis, how many years will the transition phase last? Third, how will capital costs be factored into DRG payments? Or will there be some other prospective payment mechanism? Fourth, will capital costs for movable equipment and buildings and fixtures be treated the same? Fifth, will depreciation, interest, and other types of capital expenses be treated the same? Sixth, will there be grandfathering provisions?

The above questions reflect only some of the areas of uncertainty facing hospitals as they contemplate investment decisions while awaiting the final inclusion of capital costs into PPS. What, if any, impact of this uncertainty has there been or will there be on investment decisions and, hence, capital costs of hospitals? Will hospitals gamble and undertake costly capital projects, perhaps hoping for grandfathering provisions? Or are hospitals risk averse and will lower their rate of acquiring new physical capital? Will there be a change in the composition of investment to movable equipment which usually can be depreciated faster than buildings and fixtures? Aside from the uncertainty about the ultimate treatment of capital costs under PPS, there might have been other changes directly induced by PPS. Of particular interest to this investigation is the potential change in the price of capital goods relative to other hospital inputs and its potential impact on investment.

The establishment of a federal prospective payment system occurred during the last phases of a deep recession that was marked by unusually high interest rates and at a time of upheaval in hospital, physician, and health insurance markets. HMOs gained new vigor and PPOs became a hot new institutional form. Physician supply increased to levels not seen for over 50 years. Young physicians found it more difficult to establish new practices than their predecessors. Medicare froze Part B physician fees. The federal government changed reimbursement rules to encourage HMOs to enroll Medicare beneficiaries. These and other changes in health care markets make it difficult, if not impossible, to attribute changes in hospital behavior to PPS. However, while this study cannot establish causal relationships, it does report the actual behavior of the capital costs of hospitals for the first few years of PPS. It examines both levels and trends of capital costs. Also examined are patterns of capital costs by hospital characteristics such as the number of beds. The study, on occasion, suggests tentative reasons for some of the observed patterns of capital costs.

1.1 Prior Studies

Until recently, there was little direct concern about the capital costs of hospitals. Instead, the indirect impact of capital on the overall cost of inpatient services garnered the most attention. Indeed, there has been much research on the impact of certificate-of-need laws and similar programs on the acquisition of physical capital and the subsequent impact on inpatient costs. Only three of the studies cited below present data on capital costs, all of which is prior to PPS. Thus, this study is the only one that focuses on the actual behavior of accounting capital costs since the inception of PPS.

There have been four major lines of investigation of capital costs. First has been the impact of cost-based reimbursement on the growth of total hospital capital costs and the consequent expenditures by Medicare for its share of the capital costs (Kinney and Lefkowitz, 1982; Anderson and Ginsburg, 1983; Cohodes and Kinkead, 1984; Cromwell, Wedig, and Sloan, 1985). While the focus of the first three articles was on policy options for changing the capital reimbursement mechanism, some analysis was presented and the results will be contrasted to ours. A second line of research has been descriptive analysis of hospital capital costs over time (Cromwell, Wedig, and Sloan, 1985). Pertinent results from this in-depth analysis which covered the period 1971-81 are discussed in conjunction with results of our study. The third set of studies has drawn implications of cost-based reimbursement on capital structure (Wedig, *et al*., 1988; Sloan, *et al*., 1988; Valvona and Sloan, 1988). These empirical articles focus primarily on financial variables such as the debt/asset ratio and the return on assets. While these articles are important, they have limited applicability to the focus of this investigation. A fourth area has been the effect of financing mechanisms on the acquisition of capital assets (Cohodes and Kinkead, 1984). To a large extent the Cohodes and Kinkead book describes institutional aspects of finance markets and the potential impact on segments of the hospital industry. There is, again, limited applicability to our investigation.

1.2 Hypotheses

Two distinctive features of investment are that it generates accounting capital costs over many years and that there are usually long lead times in undertaking large-scale construction. The consequence of these two features is that any impact of PPS upon accounting capital costs may not occur until several years after its inception. Although well known, it is worth repeating that accounting capital costs are not the same as real, effective costs of capital that face hospitals when making investment decisions. However, given that investment generates accounting capital costs that is reimbursed by Medicare, it is important to document these accounting capital costs and to understand the factors that might influence investment.

In order to make predictions about the behavior of investment and accounting capital costs, it is necessary to understand the economic constraints created by PPS that face hospitals. Of the various facets of PPS, the two that are most relevant are the DRG payments and the treatment of capital costs as a "passthrough." The separate impact of each of these is discussed first and then the interaction between them is explored. Next, the effects of uncertainty (described earlier), the long lags in investment behavior, and economy-wide factors are taken into consideration in order to make predictions about trends in capital costs.

By paying a set amount per diagnosis, PPS imposes a revenue constraint per admission on hospitals. The incentives this creates will depend largely on the cost structure of the hospitals, whether services are produced at a cost above or below the DRG rates, and the goals of hospitals. Assume, initially, that all hospitals do not seek profits and that pre-PPS admission rates produce losses under DRG payment rates. The effect upon a particular hospital's admissions depends on a hospital's cost schedule. If it can attain lower costs per case by changing admissions then it will attempt to do so (lowering admissions will likely be easier to achieve than increasing admissions). If changing admissions cannot prevent losses, then the hospital needs to change its behavior to become more efficient so as to get to a lower overall cost schedule. The net effect of DRG payments on admissions is thus uncertain. There is, however, an incentive to minimize hospital costs per admission. Dropping the assumption that all hospitals do not seek profits does not eliminate the uncertainty about the impact of DRG payments on admissions and might introduce uncertainty about the impact upon cost minimization in a dynamic situation. Some analysts, however, anticipated that paying hospitals on a per case basis instead of a per discharge basis would create incentive for hospitals to increase admissions (e.g., Guterman and Dobson, 1986).

Conventional wisdom holds that the DRG payment rates put pressure on hospitals to constrain the growth in usage of non-capital inputs. In turn, the change from cost-based reimbursement to prospective reimbursement implies that hospitals now face full instead of partial prices for non-capital inputs. That is, for a market price of, say, $20 per unit of input, under cost-based reimbursement, hospitals faced an effective price less than $20; hence, with DRGs, hospitals now face the full $20 price. If conventional wisdom is correct, then the price of capital inputs relative to other inputs declined with the introduction of DRG payments (ignoring other changes that might affect the price of capital). Thus, to the extent capital inputs can be substituted for non-capital inputs, the decline in the relative price of capital implies, for providing a given level of output (admissions), that hospitals would want to employ more capital and thus would undertake new investment. If output changes, then the impact of a decline in the relative price of capital on investment depends on how output changes. If output increases, then new investment will still be desired. If output decreases, it depends on whether the impact on desired capital usage of a decline in output is greater than the impact of a lower relative price of capital. Thus when output is simultaneously declining with a decline in the relative price of capital, the effect on investment is ambiguous.

What is the net impact between the effect of DRG payments on admissions and the decline in the relative price of capital on investment? As should be clear, from a theoretical view, the net impact on investment is ambiguous. To make predictions about new investment and hence, accounting capital costs, other factors need to be taken into consideration.

The following facts are considered in making predictions. First, the finding by Guterman and Dobson (1986) that Medicare admissions declined during the first year of PPS was confirmed in our data and that the decline continued through the reporting period beginning October 1, 1985 (the most recent data available for this study). Second, tax-exempt financing increased almost 300 percent between 1984 and 1985 with about one-third accounted for by refunding old debt and the rest attributed to new capital spending (ProPAC, June 1988). Third, long-term interest rates started a sustained decline after mid-1984.*

In addition to the above facts, the following assumptions are made. First, because of the difficulty in terminating investment decisions already made and construction in progress, gross investment would not be affected during the earliest year(s) of PPS. Second, because of hospital budget constraints implied by DRG payments, non-capital expenses will not increase as fast as costs of capital. Third, because of uncertainty about the treatment of investment undertaken between the implementation of PPS and the inclusion of capital costs into the system, hospitals will try to change the mix of investments so as increase the share in physical assets that can be quickly depreciated. Fourth, because of the continued treatment of capital costs as passthroughs, the relative price of capital declined after the implementation of PPS.

The above theory, facts, and assumptions are used to formulate the following hypotheses. First, capital costs will continue to increase during the first few years after the implementation of PPS. Second, the growth rate of capital costs will exceed the growth rate of total costs leading to an increasing ratio of capital costs to total costs. Third, with growing capital costs and declining hospital admissions/discharges, capital costs per discharge will increase. Fourth, increases in the depreciation for movable equipment should exceed increases in depreciation for buildings and fixtures.

1.3 Data Base

The data used in this analysis came primarily from Medicare Cost Reports (MCRs) in the four Medicare payment periods TEFRA (FY1983) through PPS 3 (FY1986). Supplemental data also came from corresponding American Hospital Association (AHA) annual surveys, from the Area Resource File (ARF), and data constructed from miscellaneous sources.

Analyzed hospitals included nonfederal, short-term, acute-care hospitals for which a MCR was received in all four periods. The following types of hospitals were not analyzed: (1) hospitals in PPS-waivered states (Maryland, Massachusetts, New Jersey, and New York), (2) hospitals exempt from the PPS (e.g., children's hospitals), and (3) hospitals which are not exempt from the PPS but for which a MCR was not available in all four analysis periods. A total of 3,795 hospitals were available for analysis. However, because of item nonresponse, especially during TEFRA, the number of observations used in calculating any one statistic is usually less than 3,795.

Since the number of hospitals available for analysis is less than the universe of eligible hospitals, a subanalysis was undertaken to determine if the analysis sample (cohort) was representative of all eligible hospitals. The cohort hospitals were contrasted to the universe of eligible hospitals by comparing the following characteristics: urban/rural status, bedsize, teaching status, ownership, and region. The following performance indicators were also compared: admissions, occupancy rates, length of stay, and cost per adjusted admission.

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*Prior to 1984, long-term interest rates peaked during 1981/2, declined in 1983, then rose until about mid-1984. Sources: Statistical Abstract of the United States: 1987 and Monetary Trends (August 1988).

The analysis indicated that the cohort under-represents large urban hospitals, major teaching hospitals, and proprietary hospitals. Cohort hospitals, relative to the universe of hospitals, averaged about four percent fewer hospital admissions (the difference became larger over time), a three percent lower length-of-stay, two percent lower occupancy rates, and a 1.7 percent lower average cost per adjusted admission. Because of these differences, when possible, capital costs are also analyzed by controlling for hospital characteristics.

In addition to the usual problems of incorrectly entered data, etc., there were other serious problems with the MCR data. The MCR data, as originally received, had true zeros and missing data both coded as zeros; thus making it impossible to distinguish between the two. This presents a problem on how to treat zero values of particular variables. In some instances (for example, inpatient operating costs and inpatient discharges), it does not make sense for a hospital to have zero values and still be classified as a hospital. With regard to capital costs, it might be possible that some hospitals built over thirty years ago have the building completely depreciated. However, with rapidly changing technology, it is less likely that equipment would also be completely depreciated. The original number of zero values for the depreciation categories seemed to be implausibly high. Thus, for the purposes of this study, zero values of all variables were recoded to missing values, thus deleting the observations in calculating statistics.

Another problem with the MCR data, which is confounded with the above problem, was how hospitals completed MCRs. As noted by ProPAC (April 1987), hospitals did not always distinguish between fixed and movable equipment, thus rendering suspect the individual depreciation values for these two categories. The total depreciation values reported in Chapter 2 of this study were obtained by adding the two above individual depreciation values together. For the purposes of this specific calculation, if one value was positive and the other missing, the missing value was treated as a zero.

2.0 RESULTS

As indicated in Section 1, hypotheses, based on economic theory, about the change in accounting capital costs over time are not easy to make. Therefore, instead of a behavioral analysis, only a descriptive analysis is presented here. Only tentative reasons are advanced to explain observed patterns. Seven types of capital costs are analyzed (see Table 1 for concise definitions): (1) total hospital/facility capital costs, (2) total hospital capital costs, (3) total depreciation, (4) total depreciation on buildings and fixtures, (5) total depreciation on movable equipment, (6) Title XVIII (18) total hospital capital costs, and (7) for proprietary hospitals only, return on equity.

Of the nine components of allowable capital costs,* only annual depreciation is examined in detail in this study. There are three basic reasons why annual depreciation receives such attention. First, of all of the components of allowable capital costs, annual depreciation is the largest single component and usually comprises more than 50 percent of total capital costs. Second, changes in annual depreciation provides information about the rate of capital formation in hospitals. For instance, if annual depreciation is increasing, then there are net additions to the capital stock of the hospital. Annual depreciation is equal to the annual share of depreciation of old assets plus the annual share of depreciation of newly acquired assets minus the salvage value of disposed assets. Thus, the only way annual depreciation can increase is if the depreciation on the newly acquired assets is sufficiently large to offset declines in the other two factors. Which means that there is a net addition to the capital stock. (However, since capital costs are not adjusted for price inflation, changes in the real value of assets cannot be detected so easily.) As long as annual depreciation is positive, then accumulated depreciation is increasing. Increases in accumulated depreciation, thus, do not provide information about capital formation. Third, data from the MCRs do not allow examination of the other major components such as interest and the leasing of capital equipment.

Each of the above seven types of capital costs is analyzed as: (1) a dollar level, (2) as a percent of inpatient operating expenses (or, for types 6 and 7, as a percent of Medicare inpatient operating expenses), and (3) per hospital discharge (or, for types 6 and 7, per Medicare discharge). Both

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*Allowable capital costs include: (1) depreciation, (2) taxes on capital assets, (3) leases and rentals of capital assets, (4) costs of betterments and improvements, (5) costs of minor equipment, (6) insurance on assets (7) interest expense, (8) return on equity, and (9) capital cost of related organizations. For a detailed description, see the Prospective Payment Assessment Commission's Technical Appendixes to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services, April 1, 1986, pp. 40-42.

TABLE 1

TRIM POINTS FOR CAPITAL COST MEASURES

	Dollar Levels Per Hospital		Share Of Inpatient Operating Costs**		Per Discharge**	
	Low	High	Low	High	Low	High
Total Hospital/Facility Capital Costs (includes LTC beds, etc.)	> $0	--	> 0	≤ .40	> $0	--
Total Hospital Capital Costs (excludes LTC beds, etc.)	> $0	--	> 0	≤ .40	> $0	--
Total Depreciation*	> $0	--	> 0	≤ .40	> $0	--
-Buildings and Fixtures*	> $0	≤ $30,000,000	> 0	≤ .40	> $0	≤ $2,500
-Movable Equipment*	> $0	≤ $12,000,000	> 0	≤ .40	> $0	≤ $2,000
Title 18 Total Hospital Capital Costs***	> $0	≤ $12,000,000	> 0	≤ .40	> $0	≤ $4,800
Part A Reimbursed Return on Equity Capital (Proprietary Hospitals Only)***	> $0	--	> 0	≤ .40	> $0	--

*Before reclassification or adjustment.
**Also set missing if cost per inpatient discharge less $800 or greater than $12,000.
***As a share of Medicare inpatient operating costs or per Medicare discharge.

Note: Because of the various screens used at different levels of variable definition, some of the share and per discharge variables have implicit screens not listed above.

levels and trends of these measures over the four periods are discussed in Section 2.1. Medicare capital costs, by hospital characteristic, are further analyzed in Section 2.2. Depreciation on buildings and fixtures and movable equipment are discussed in greater detail in Section 2.3. When possible, results from other studies are compared to the findings reported below.

2.1 All Capital Costs

This section reports the levels and movement over time of the 21 basic capital measures. Per hospital means are presented for capital costs, capital costs as a share of operating expenses, and capital costs per discharge. The per hospital values presented in the tables are calculated by taking the mean of the unweighted, individual hospital values of each capital measure. Percentage changes between periods, on the other hand, are calculated using the mean values presented in the tables.

2.1.1 Capital Costs per Hospital

All but one of our measures of capital costs increased on an annual basis over the entire period from TEFRA through PPS 3 (Table 2). The only exception was return on equity (discussed below). Most of the annual increases were greater than ten percent and, in one instance, was greater than 20 percent. These rates of increase exceeded both the rate of inflation of medical care prices (which in turn was higher than the general rate of inflation) and the rate of increase of expenditures on health services and supplies over this period. As indicated by the growth of depreciation, net capital formation continued over the entire period.

Except for return on equity, all measures of capital costs per hospital increased from year to year over the entire period. Mean total capital costs per hospital increased from 1.4 million dollars during TEFRA to 2.1 million dollars during PPS 3.* Total depreciation increased from 875 thousand dollars during TEFRA to 1.3 million dollars per hospital during PPS 3. Both components of depreciation, buildings and movable equipment, had year-to-year increases. The increase in depreciation indicates that capital formation was still continuing during the early years of PPS. Medicare's capital costs for hospital inpatients increased from 498 thousand dollars to 712 thousand dollars per hospital over the four years.

Total depreciation per hospital increased at an average annual rate of 12.3 percent, a somewhat slower rate than the 14.4 percent rate for total capital costs per hospital. Thus, the combined other components of capital

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*Total hospital/facility capital costs (type 1) and total hospital capital costs (type 2) are very similar. Therefore, unless stated otherwise, the phrase "total capital costs" and associated statistics refer to type 2.

TABLE 2

MEAN CAPITAL COSTS PER HOSPITAL FOR SHORT-TERM ACUTE-CARE HOSPITALS IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	PERCENTAGE CHANGE BETWEEN TEFRA And PPS 1	PERCENTAGE CHANGE BETWEEN PPS 1 And PPS 2	PERCENTAGE CHANGE BETWEEN PPS 2 And PPS 3
Total Hospital/Facility Capital Costs (includes LTC beds, etc.)	$1,401,416	$1,601,826	$1,888,350	$2,166,119	14.5%	13.4%	16.5%	13.7%
Total Hospital Capital Costs (excludes LTC beds, etc.)	1,391,408	1,590,290	1,871,985	2,146,171	14.4	13.4	16.3	13.7
Total Depreciation**	874,855	1,009,653	1,143,376	1,264,657	12.3	14.3	12.4	10.1
-Buildings and Fixtures**	560,177	642,426	732,782	798,616	11.8	13.7	13.2	8.6
-Movable Equipment**	427,769	501,472	572,766	648,166	13.9	15.9	13.3	12.4
Title 18 Total Hospital Capital Costs	497,762	517,610	634,338	711,623	11.9	3.9	20.3	11.5
Part A Reimbursed Return on Equity Capital (Proprietary Hospitals Only)	294,533	317,753	230,337	185,069	-15.5	7.6	-32.2	-21.9

Notes:

1. The approximate number of observations per period are: (1) 3,791 for Total and Title 18 capital costs, (2) 3,660 for total depreciation, (3) 3,548 for depreciation on buildings and fixtures, (4) 2,800 for depreciation on movable equipment, and (5) 440 for return on equity.

2. Reported values are unweighted means. For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available for all four periods.
**Before reclassification or adjustment.

Source: Medicare Cost Reports (MCRs).

costs (e.g., interest payments, leases on equipment) increased at a higher rate than depreciation. The compounded average annual rate of increase of depreciation on movable equipment exceeded the rate for depreciation on buildings and fixtures by 2.1 percentage points. Medicare capital costs per hospital increased at an annual rate of 11.9 percent, about 2.5 percentage points lower than overall capital costs.

Individual annual increases were generally double digit. Except for depreciation, the rate of increase was highest between PPS 1 and PPS 2. Total capital costs per hospital was 16.3 percent higher in PPS 2 than during PPS 1. The single largest annual increase, 20.3 percent, was for Medicare capital costs between PPS 1 and PPS 2. (Special calculations were necessary to obtain Medicare capital costs for PPS 1; this might account for both the low 3.9 percent increase between TEFRA and PPS 1 and the subsequent 20.3 percent increase.) Rates of increase for depreciation, while still double digit, declined continuously between TEFRA and PPS 3 from 12.3 percent to 10.1 percent. Only during PPS 2 did depreciation on buildings and fixtures increase at about the same rate as depreciation on movable equipment. During PPS 3, the rate of increase on depreciation on movable equipment was 44 percent higher than the rate of increase on depreciation on buildings and fixtures. These comparisons between depreciation on movable equipment and buildings and fixtures should be taken with caution. As noted in section 3 of Chapter 1, there are coding problems with these two items.

Return on equity fell from 295 thousand dollars during TEFRA to 185 thousand dollars per hospital during PPS 3. One likely reason for the decline of return on equity was the fall in the adjusted rate of return that was used in Medicare's formula for determining return on equity payments. At about the same time PPS was implemented, the adjustment factor was lowered from 1.5 to 1.0 (effectively eliminating the adjustment factor).* Another possible reason is that with the decline of both long-term and short-term interest rates during the mid-1980s, it is likely that the rate of interest earned by the Hospital Insurance Trust Fund also fell, thereby contributing to continuing declines in return on equity payments over the four year period.

2.1.2 Capital Costs as a Share of Inpatient Operating Expenses

All measures of capital costs as a share of inpatient operating expenses, except return on equity, increased over the four year period (Table 3). This indicates that capital costs grew faster than inpatient

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*Federal Register 48:171 (September 1, 1983), pg. 39811. The rule change applied to all reporting periods beginning on or after April 20, 1983.

TABLE 3

MEAN CAPITAL COSTS AS A PERCENTAGE OF INPATIENT OPERATING COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	PERCENTAGE CHANGE BETWEEN TEFRA And PPS 1	PERCENTAGE CHANGE BETWEEN PPS 1 And PPS 2	PERCENTAGE CHANGE BETWEEN PPS 2 And PPS 3
Total Hospital/Facility Capital Costs (includes LTC beds, etc.)	8.6%	9.5%	10.6%	11.3%	9.1%	10.0%	10.8%	6.4%
Total Hospital Capital Costs (excludes LTC beds, etc.)	8.3	9.2	10.2	10.9	9.1	10.3	10.7	6.4
Total Depreciation**	5.4	6.1	6.5	6.7	7.5	11.9	6.5	4.1
-Buildings and Fixtures**	3.5	3.9	4.2	4.3	7.3	10.9	6.7	4.2
-Movable Equipment**	2.6	3.0	3.3	3.4	9.0	13.5	8.3	5.1
Title 18 Total Hospital Capital Costs***	8.0	8.7	10.4	11.0	10.7	9.0	17.6	5.6
Part A Reimbursed Return on Equity Capital (Proprietary Hospitals Only)***	6.1	5.3	4.9	3.6	-18.0	-15.0	-8.3	-30.6

Notes:

1. The approximate number of observations per period are: (1) 3,665 for Total and Title 18 capital costs [3,160 in TEFRA], (2) 3,560 for total depreciation [3,070 in TEFRA], (3) 3,450 for depreciation on buildings and fixtures [2,970 in TEFRA], (4) 2,690 for depreciation on movable equipment [2,358 for TEFRA], and (5) 440 for return on equity [344 for TEFRA].

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes:
*Only for those hospitals which had MCRs available for all four periods.
**Before reclassification or adjustment.
***As a percentage of Medicare Inpatient Costs.

Source: licare Cost Reports (MCRs).

operating costs over this period. This result stands in contrast to the finding of Cromwell, Wedig, and Sloan (1985) that capital costs, as a share of total expenses, remained stable between 1971 and 1981. Total capital costs, as a share of inpatient operating expenses, increased from 8.6 percent during TEFRA to 11.3 percent per hospital during PPS 3. ProPAC's (June 1988, pp. 39-41) analysis of AHA panel survey data indicates that depreciation plus interest expenses as a proportion of operating costs continuously increased from 7.4 percent during 1983 to 9.3 percent during 1987 (their Table 2-4). Part of the discrepancy between the two sets of figures can probably be attributed to the narrower definition of capital costs in the AHA data. For instance, the AHA definition of capital costs includes only depreciation and interest expenses but not capital costs such as the leasing of capital assets. Because ProPAC did not indicate its treatment of outliers, sample size, nor the characteristics of the hospitals, other sources of discrepancy that exist between the AHA panel data and the cohort of MCR data cannot be ascertained. Data presented in Section 2.2.3 of this chapter indicates that the ratio of depreceiation to operating costs is sensitive to characteristics such as the number of beds and the geographic distribution of the hospitals.

As expected from the analysis of capital costs levels in the previous section, total depreciation as a percent of operating costs did not grow as fast as overall total capital costs. The proportion of Medicare capital costs to Medicare inpatient operating costs was slightly less than the proportion for total capital costs for TEFRA and PPS 1 but was slightly higher during the last two periods. Return on equity, as a share of Medicare inpatient operating costs, declined steadily over the four periods.

For three of the seven capital share measures, the largest year-to-year increase was between PPS 1 and PPS 2. As before, Medicare capital costs rose the most between these two periods. All of the depreciation ratios increased, but, unlike the other measures, at a decreasing rate over the entire period. While return on equity decreased from year to year, the smallest decrease was between PPS 1 and PPS 2.

2.1.3 Capital Costs per Discharge

With only one exception, all measures of capital costs per discharge increased each year (Table 4). Total hospital capital costs per discharge increased 86 percent from $218 during TEFRA to $406 per hospital during PPS 3. These figures, except for PPS 3, are similar to capital costs per admission calculated by ProPAC from AHA panel data. ProPAC's analysis indicates capital costs per admission increased from $220 to $370, an increase

TABLE 4

MEAN CAPITAL COSTS PER DISCHARGE PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
Total Hospital/Facility Capital Costs (includes LTC beds, etc.)	$218	$265	$337	$406	20.7%	19.7%	23.9%	18.6%
Total Hospital Capital Costs (excludes LTC beds, etc.)	211	257	326	393	20.8	19.8	23.9	18.7
Total Depreciation**	134	167	202	236	18.7	22.1	18.5	15.6
-Buildings and Fixtures**	87	107	131	154	18.8	20.4	19.8	16.0
-Movable Equipment**	65	81	99	117	19.8	22.3	20.4	16.7
Title 18 Total Hospital Capital Costs***	225	249	332	390	18.3	10.2	28.5	16.2
Part A Reimbursed Return on Equity Capital (Proprietary Hospitals Only)***	198	221	169	176	-4.0	10.8	-26.7	3.8

Notes:

1. The approximate number of observations per period are: (1) 3,670 for Total and Title 18 capital costs [3,160 in TEFRA], (2) 3,560 for total depreciation [3,070 in TEFRA], (3) 3,450 for depreciation on buildings and fixtures [2,970 in TEFRA], (4) 2,690 for depreciation on movable equipment [2,358 for TEFRA], and (5) 440 for return on equity [343 for TEFRA].

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes:

*Only for those hospitals which had MCRs available for all four periods.
**Before reclassification or adjustment.
***Per Medicare Discharge.

Source: Medicare Cost Reports (MCRs).

of 68 percent (their Figure 2-2).* These large increases reflect both the growth of capital costs and the decline in discharges (admissions). Total discharges declined by a compounded average annual rate of 4.1 percent while Medicare discharges declined by a compounded average annual rate of 5.2 percent.

All depreciation measures increased each year. Total depreciation per discharge rose from $134 during TEFRA to $236 during PPS 3. Medicare capital costs per Medicare discharge were lower than total capital costs per discharge in two periods. The largest compounded average annual rate of increase over the period was for total hospital capital costs per discharge at 20.7 percent followed by Medicare capital costs per Medicare discharge at 18.3 percent. As before, the single largest annual increase was for Medicare capital costs at 28.6 percent between PPS 1 and PPS 2.

2.1.4 Discussion

Analysis of the MCR data provided evidence supporting all four of the predictions made in Chapter 1 about the behavior of capital costs since the implementation of PPS. Growth of capital costs continued to increase, capital's share of costs increased, capital costs per discharge increased, and depreciation on movable equipment increased more than depreciation on buildings and fixtures.

Depreciation did not grow as fast as the other components of capital costs. Depreciation, also, while still growing, grew at successively lower rates. It would thus appear that PPS has started affecting the growth rate of physical assets despite fact that Medicare still treats capital costs as passthroughs. There are, however, some unanswered questions about what exactly is happening. First, is the decline in the growth rate a permanent effect of PPS or does it reflect uncertainty about how capital costs will be ultimately reimbursed under PPS? Or does it reflect factors not directly related to PPS such as declining length of stay or declines in total discharges?

Second, what is happening to the other components of capital costs? Has there been a (temporary?) increase in the leasing of physical assets? To get an indication of what was happening to other components of capital costs, AHA annual surveys were matched to the corresponding cohort's Medicare Cost Reports. AHA data indicate that interest expense grew slightly faster than depreciation expense but with the same declining pattern of growth. The AHA evidence must be treated with caution because, for PPS 3, there was AHA data on only 2,482 of the 3,795 hospitals.

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*Because ProPAC used a bar graph to indicate capital cost per admission, AHA values indicated in our report are interpolations.

Third, what is happening to actual investment? Are there general economic factors beyond the influence of the PPS which could be affecting overall growth rates of hospital depreciation and/or investment? Fourth, did the decline in long-term interest rates after mid-1984 lead to refinancing and increased use of debt in acquiring physical assets?

2.2 Medicare Capital Costs

In this section, Medicare capital costs are examined in more detail. First, the distribution of Medicare capital costs for each of the four periods are presented. Then, dollar levels of Medicare capital costs, Medicare capital costs as a share of Medicare inpatient operating costs, and Medicare capital costs per Medicare discharge are all presented by hospital characteristics (urban/rural, bedsize, ownership, teaching status, and region).

2.2.1 Distribution of Medicare Capital Costs

Distributions of Medicare capital costs by dollar level, as a share of Medicare inpatient operating costs, and per Medicare discharge by period are presented in Table 5. The distribution of total Medicare capital costs was skewed to the right in all four periods as indicated by means exceeding medians and positive values for the skewness measure (skewness measures not in table). More than 75 percent of all hospitals had Medicare capital costs less than 1 million dollars during PPS 3. On the other hand, over five percent of hospitals had Medicare capital costs in excess of 2.5 million dollars.

The interquartile range (75th percentile minus the 25th percentile) increased from $605,928 (TEFRA) to $857,628 (PPS 3), an annual increase of 11.6 percent. (All average or annual percentage increases between TEFRA and PPS 3 are compounded average annual rates.) The increase in the interquartile range over the four periods is not indicative of large hospitals increasing in relative size. The reason is that the percentage increase in the range roughly matches the percentage increases of the means, medians, and the 75th and 25th percentiles. This interpretation is also backed by the skewness measures which changed very little over the four years. For instance, the 75th percentile increased 34.8 percent from $672,270 (TEFRA) to $951,750 (PPS 3) and the 25th percentile increased 35.0 percent from $66,342 (TEFRA) to $94,122 (PPS 3). Thus the principal findings are that the distribution of capital costs shifted to the right over the four years and that a significant number of hospitals have very large capital costs.

The distributions of Medicare capital costs per discharge and as a share of Medicare inpatient costs were also both positively skewed. While both

TABLE 5

PERCENTILES FOR CAPITAL COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS3
TITLE 18 INPATIENT CAPITAL COSTS				
100 (Maximum)	$9,613,188	$8,944,122	$10,441,908	$11,132,412
99	3,198,672	3,253,477	4,173,063	4,559,849
95	1,921,040	1,973,531	2,354,189	2,610,271
75	672,270	688,153	853,098	951,750
50 (Median)	213,522	218,289	270,612	303,708
25	66,342	67,269	85,620	94,122
5	17,959	16,857	20,472	22,342
1	7,344	7,123	7,977	9,272
0 (Minimum)	1,032	941	2,052	540
TITLE 18 INPATIENT CAPITAL COSTS AS A PERCENT OF MEDICARE INPATIENT COSTS				
100 (Maximum)	35.5%	38.7%	40.0%	39.6%
99	22.9	25.4	29.1	29.9
95	16.1	18.3	21.1	21.8
75	9.9	10.9	12.8	13.5
50 (Median)	7.0	7.5	9.1	9.7
25	4.9	5.3	6.7	7.1
5	3.2	3.4	4.2	4.6
1	2.5	2.5	3.0	3.1
0 (Minimum)	0.9	0.8	1.2	0.2
TITLE 18 INPATIENT CAPITAL COSTS PER MEDICARE DISCHARGE				
100 (Maximum)	$2,308	$1,886	$2,536	$3,839
99	868	1,027	1,342	1,483
95	554	619	792	929
75	296	322	421	498
50 (Median)	173	195	261	307
25	100	114	161	190
5	54	60	85	104
1	37	38	50	57
0 (Minimum)	11	12	17	5

Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Unweighted values from Medicare Cost Reports (MCRs).

distributions shifted up, as indicated by the increased values of most percentiles, both distributions had a slight decrease in skewness over the four periods. As a share of Medicare inpatient operating costs, Medicare capital costs, for the 75th percentile, increased 31.4 percent from 9.9 percent (TEFRA) to 13.5 percent (PPS 3) and, for the 25th percentile, increased 36.6 percent from 4.9 percent (TEFRA) to 7.1 percent (PPS 3). Similarly, for Medicare capital costs per Medicare discharge, the 75th percentile increased less than the 25th percentile. The 75th percentile increased 52.0 percent from $296 per Medicare discharge (TEFRA) to $498 per Medicare discharge (PPS 3) while the 25th percentile increased 64.3 percent from $100 per Medicare discharge (TEFRA) to $190 per Medicare discharge (PPS 3).

2.2.2 Distribution of Medicare Capital Costs By Hospital Characteristic

With only two exceptions (both between TEFRA and PPS 1), Medicare capital costs per hospital increased from year-to-year for all categories (Table 6). Between TEFRA and PPS 1, only one growth rate exceeded ten percent whereas between PPS 1 and PPS 2, all growth rates exceeded 14.5 percent and between PPS 2 and PPS 3, most growth rates exceeded 10 percent. For every category, the growth rate between PPS 1 and PPS 2 was the highest.

Not surprisingly, for both urban and rural hospitals, hospitals with more beds had higher Medicare capital costs. This positive correlation between capital costs and bedsize helps explain some of the differences in Medicare capital cost levels stratified by other characteristics. For instance, the typical teaching hospital has more beds than the typical non-teaching hospital.

While urban hospitals had much higher levels of Medicare capital costs than did rural hospitals, the growth rate of Medicare capital costs in rural hospitals (12.1 percent) was slightly higher than the growth rate in urban hospitals (11.8 percent). Competition between hospitals may be the reason that small urban hospitals have higher levels of capital costs than do small rural hospitals. Luft, et al. (1986) have argued that in more competitive markets, such as urban areas, hospitals compete by offering more services, etc. than their counterparts in less competitive markets. Growth rates of Medicare capital costs, in general, were not correlated with the number of beds. For instance, the lowest growth rate was for urban hospitals with 300-404 beds.

Medicare capital costs in state and local government (public) hospitals were considerably lower than in voluntary and proprietary hospitals. While public hospitals had, on average, slightly higher shares of Medicare patients than did voluntary or proprietary hospitals, public hospitals typically had

TABLE 6

MEAN TITLE 18 INPATIENT CAPITAL COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	PERCENTAGE DIFFERENCE BETWEEN TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$497,762	$517,610	$634,338	$711,623	11.9%	3.9%	20.3%	11.5%
Urban Hospitals	854,358	886,904	1,084,788	1,216,952	11.8	3.7	20.1	11.5
0 - 99 Beds	200,106	222,248	260,835	296,877	13.1	10.5	16.0	12.9
100 - 199 Beds	574,650	608,173	772,768	851,942	13.1	5.7	24.0	9.8
200 - 299 Beds	1,058,292	1,109,737	1,328,209	1,468,696	10.9	4.7	18.0	10.1
300 - 404 Beds	1,415,634	1,434,360	1,702,078	1,858,544	9.1	1.3	17.1	8.8
405 - 504 Beds	1,661,515	1,727,985	2,112,814	2,385,175	12.1	3.9	20.1	12.1
505 + Beds	2,271,078	2,275,441	2,898,367	3,461,505	14.0	0.2	24.2	17.8
Rural Hospitals	188,064	196,874	242,203	270,617	12.1	4.6	20.7	11.1
0 - 49 Beds	55,931	56,523	69,839	77,679	10.9	1.1	21.2	10.6
50 - 99 Beds	172,556	177,356	214,692	236,180	10.5	2.7	19.1	9.5
100 - 169 Beds	368,371	402,522	509,353	568,528	14.5	8.9	23.5	11.0
170 + Beds	774,249	802,089	971,831	1,108,980	12.0	3.5	19.2	13.2
Ownership								
State & Local Gov't	199,404	202,272	257,820	290,670	12.6	1.4	24.3	12.0
Voluntary	650,119	677,723	825,896	926,013	11.8	4.2	19.8	11.4
Proprietary	567,948	594,223	722,291	805,560	11.7	4.5	19.5	10.9
Teaching Status								
Non-teaching	365,427	383,971	471,301	525,308	12.1	5.0	20.5	10.8
Other Teaching	1,247,725	1,288,481	1,562,010	1,759,359	11.5	3.2	19.3	11.9
Major Teaching	1,218,008	1,151,302	1,458,939	1,720,290	11.5	-5.6	23.7	16.5
Census Division								
New England	383,293	385,257	494,258	540,252	11.4	0.5	24.9	8.9
Mid Atlantic	895,695	941,665	1,164,359	1,279,976	11.9	5.0	21.2	9.5
South Atlantic	585,794	627,285	781,765	901,487	14.4	6.8	22.0	14.2
East North Central	647,701	663,505	791,247	868,774	9.8	2.4	17.6	9.3
East South Central	378,441	417,325	518,563	582,657	14.4	9.8	21.7	11.7
West North Central	319,907	333,745	385,733	419,662	9.0	4.2	14.5	8.4
West South Central	376,965	397,876	499,132	582,723	14.5	5.4	22.7	15.5
Mountain	293,068	310,923	396,793	420,766	12.1	5.9	24.4	5.9
Pacific	639,715	632,301	784,576	883,966	10.8	-1.2	21.6	11.9

Notes: 1. 3,791 observations per period.

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available for all four periods.

Source: Medicare Cost Reports (MCRs).

only half the number of total discharges of voluntary hospitals and about 83 percent of the total discharges of proprietary hospitals. Growth rates of Medicare capital costs, however, were highest in public hospitals over the four year period as a whole. The high rates of growth of Medicare capital costs in public hospitals occurred during PPS 2 and PPS 3 while, between TEFRA and PPS 1, it had the lowest growth rate at 1.3 percent. One possibility for the initial low growth rate and the subsequent higher growth rates for public hospitals might be due to the impact on overall state and local government revenues of the sharp recession of the early 1980s and the recovery that began in late 1983.*

Medicare capital costs in non-teaching hospitals was about one third of that in teaching hospitals. As noted above, the typical non-teaching hospital has fewer beds than the typical teaching hospital. Another reason teaching hospitals had higher Medicare capital costs than non-teaching hospitals is that teaching hospitals traditionally tend to be the first acquirers of major medical technologies (cf., Hillman, et al., 1986). The difference between "other" and "major" teaching hospitals probably is not significant because classification is dependent on the ratio of interns and residents per bed (25 per 100 beds is the boundary). Some teaching hospitals have such a large number of beds that they are classified as "other" instead of "major" teaching.

Medicare capital costs per hospital were highest in the Middle Atlantic census division (Pennsylvania only, NY and NJ waivered) and lowest in the West North Central and Mountain census divisions. Hospitals in the three southern census divisions had the highest average growth rates of Medicare capital costs and were in excess of 14 percent.

2.2.3 Share of Medicare Inpatient Operating Costs

As discussed in the previous section, the level of capital costs and bedsize of hospitals are positively correlated. By standardizing Medicare capital costs by Medicare inpatient operating costs, the effects of the scale of operations (e.g., beds) and regional price differences on Medicare capital costs are partially eliminated. Hence, comparisons between characteristics other than bedsize are not confounded by bedsize.

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*State and local government revenues from all sources (including Federal grants, etc.) increased at a compound average annual rate of 10.87 percent from 1975 through 1981. Growth rates since 1981 were: 7.78% (1981/2), 8.01% (1982/3), 9.42% (1983/4), 9.87% (1984/85). Source: Statistical Abstract of the United States: 1987 and 1988, 107th and 108th editions; Tables 438 (1987) and 437 (1988). Note also that overall capital outlays actually declined slightly between 1981 and 1983 while outlays for current operations increased. Separate data on hospital capital outlays not reported in cited tables.

Medicare capital costs as a share of Medicare inpatient operating costs increased steadily from eight percent during TEFRA to eleven percent during PPS 3 (Table 7). While the correlation was not perfect, categories which had the highest average growth rates for levels of Medicare capital costs also had the highest average growth rates for Medicare shares. Regardless of category, the highest year-to-year growth rates were between PPS 1 and PPS 2.

Urban hospitals typically had higher shares than did rural hospitals; however, this was not uniformly the case. For instance, the largest urban hospitals usually had lower shares than any rural bedsize category. Small rural hospitals had lower shares than small urban hospitals. For rural hospitals, the larger the hospital, the higher the share. On the other hand, for urban hospitals, the share tended to decline with higher bedsize categories. Thus, at least for urban hospitals, there appears to be evidence of economies of scale for capital costs. (The largest bedsize class for rural hospitals represents a much smaller number of beds than the larger urban bedsize categories.) Also, for rural hospitals, confounding factors may be present; they are discussed with regard to capital costs per discharge.

Public hospitals had the lowest Medicare capital share while proprietary hospitals had the highest share. This result is consistent with evidence from Kinney and Lefkowitz (1982) and Cromwell, Wedig, and Sloan (1985). However, unlike Cromwell, Wedig, and Sloan (1985), little evidence was found for convergence in Medicare capital shares between the ownership categories. Major teaching hospitals had even lower Medicare capital shares than the largest urban hospitals. The likely reason for this is that while teaching hospitals have very high levels of capital costs, they have even higher levels of labor expenses. This result is consistent with the general notion that capital and labor inputs in hospitals tend to have a complementary relationship instead of being substitutes. Hospitals in the New England census division tended to have the lowest Medicare shares while hospitals in the East South Central census division had the highest.

2.2.4 Capital Cost Per Medicare Discharge

Medicare capital costs per Medicare discharge continually increased from $225 per discharge to $390 per discharge (Table 8). The average growth rate per discharge (18.3 percent) was higher than the average growth rate of Medicare capital costs (11.9 percent), thus reflecting the decline of Medicare discharges over the four years. With only a four exceptions, average growth rates over the entire period ranged from 15 percent to 21.8 percent. As has been the case thus far, the highest year-to-year growth rates are always between PPS 1 and PPS 2.

TABLE 7

MEAN TITLE 18 INPATIENT CAPITAL COSTS AS A PERCENTAGE OF MEDICARE INPATIENT OPERATING COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	8.0%	8.7%	10.4%	11.0%	10.7%	9.0%	17.6%	5.6%
Urban Hospitals	8.8	9.4	10.9	11.5	9.0	7.4	15.0	4.6
0 - 99 Beds	8.1	9.0	11.0	11.6	11.8	9.6	20.6	5.1
100 - 199 Beds	9.8	10.4	12.2	12.8	8.8	5.9	15.5	4.9
200 - 299 Beds	9.3	10.1	11.1	11.5	7.1	8.2	9.2	3.8
300 - 404 Beds	8.4	9.0	10.1	10.4	7.1	6.7	11.7	2.9
405 - 504 Beds	7.6	8.0	9.2	9.5	7.4	5.0	14.0	3.2
505 + Beds	6.4	6.8	8.0	8.9	10.8	5.5	17.1	9.8
Rural Hospitals	7.3	8.2	10.0	10.6	12.4	10.6	20.0	6.5
0 - 49 Beds	6.4	7.2	8.9	9.7	13.8	11.0	21.8	8.6
50 - 99 Beds	7.9	8.7	10.5	11.0	11.2	9.4	18.9	5.3
100 - 169 Beds	8.2	9.4	11.5	12.1	12.9	13.3	20.5	4.9
170 + Beds	8.8	9.6	11.0	11.4	8.9	9.3	13.6	3.7
Ownership								
State & Local Gov't	6.5	7.1	8.8	9.4	12.0	8.4	20.9	6.7
Voluntary	8.0	8.7	10.2	10.7	9.9	8.4	16.2	5.0
Proprietary	11.2	12.4	14.6	15.6	10.9	9.9	16.7	6.1
Teaching Status								
Non-teaching	8.0	8.8	10.6	11.2	11.1	9.5	18.1	5.8
Other Teaching	7.7	8.3	9.6	10.0	8.9	8.1	14.4	4.1
Major Teaching	6.0	5.6	6.4	7.0	5.1	-8.1	13.9	9.4
Census Division								
New England	5.6	6.3	7.3	7.9	11.2	11.5	14.5	7.6
Mid Atlantic	8.2	8.8	10.4	10.5	8.2	7.3	16.5	1.0
South Atlantic	8.4	9.0	10.8	11.5	10.4	7.1	18.0	6.3
East North Central	7.8	8.3	9.8	10.1	8.8	7.0	15.8	3.6
East South Central	8.3	9.5	11.6	12.3	13.4	14.3	19.2	6.5
West North Central	7.4	8.3	9.9	10.2	10.9	11.3	17.8	3.5
West South Central	8.4	9.3	11.2	12.0	11.9	10.0	18.5	7.2
Mountain	7.2	8.5	10.3	11.3	14.7	16.0	19.3	8.7
Pacific	8.3	8.7	10.3	11.0	9.3	4.4	17.0	6.6

Notes: 1. 3,665 observations per period (3,158 for TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available for all four periods.

Source: Medicare Cost Reports (MCRs).

TABLE 8

MEAN TITLE 18 INPATIENT CAPITAL COSTS PER MEDICARE DISCHARGE PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$225	$249	$332	$390	18.3%	10.2%	28.5%	16.2%
Urban Hospitals	312	334	439	515	16.7	7.0	27.3	15.8
0 - 99 Beds	238	258	365	451	21.3	8.0	34.8	21.1
100 - 199 Beds	351	374	495	570	16.2	6.4	27.9	14.3
200 - 299 Beds	355	386	480	550	14.6	8.5	21.7	13.5
300 - 404 Beds	313	345	437	497	15.4	9.8	23.5	12.8
405 - 504 Beds	321	338	435	501	14.8	5.1	25.2	14.2
505 + Beds	277	291	385	471	17.7	5.0	27.9	20.3
Rural Hospitals	155	177	241	283	20.1	13.4	30.6	16.1
0 - 49 Beds	123	142	196	236	21.8	14.4	32.4	18.6
50 - 99 Beds	169	189	255	294	18.4	11.4	29.7	14.2
100 - 169 Beds	194	231	312	367	21.3	17.3	30.3	16.2
170 + Beds	224	251	326	373	17.0	11.3	26.3	13.3
Ownership								
State & Local Gov't	143	163	222	263	20.4	13.2	30.8	17.1
Voluntary	236	262	344	397	17.3	10.3	27.4	14.3
Proprietary	372	388	520	634	17.8	4.4	29.2	19.8
Teaching Status								
Non-teaching	211	235	315	371	18.9	11.0	29.3	16.4
Other Teaching	306	335	434	500	16.4	9.0	26.0	14.1
Major Teaching	370	332	417	494	9.7	-10.7	22.7	17.0
Census Division								
New England	182	184	238	288	15.3	1.2	25.7	19.0
Mid Atlantic	291	308	399	440	13.8	5.8	25.9	9.6
South Atlantic	226	245	329	403	19.3	8.0	29.4	20.4
East North Central	247	264	344	387	15.0	6.5	26.5	11.9
East South Central	175	212	282	328	21.0	19.2	28.6	15.2
West North Central	179	204	266	300	17.2	12.6	26.9	12.0
West South Central	222	243	336	416	21.0	9.1	32.6	21.2
Mountain	190	224	299	344	19.9	16.5	29.0	14.1
Pacific	307	332	441	523	17.7	7.8	28.3	17.1

Notes: 1. 3,665 observations per period (3,156 for TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available for all four periods.

Source: Medicare Cost Reports (MCRs).

Medicare capital costs per discharge were 1.8-2 times higher in urban hospitals than in rural hospitals. The difference, however, declined over the four year period. The highest rate per discharge in rural hospitals was lower than the lowest urban bedsize category. Medicare capital costs per discharge for rural hospitals were positively correlated with the number of hospital beds. This, however, was not the case for urban hospitals. An explanation for the different relationships in rural and urban hospitals might be the possible correlations between size, capital costs, and casemix. Casemix and capital costs probably have a positive correlation because severe cases tend to need more inputs of all types. First, larger rural hospitals tend to be rural referral centers. Thus, for rural hospitals, casemix complexity would be strongly correlated with size and hence, any correlation between size and capital costs reflects casemix. Second, as suggested previously, small urban hospitals have higher capital costs than their rural counterparts because, in order to compete, small urban hospitals need to offer services similar to those in larger urban hospitals. It is also likely that differences in casemix among differing sizes of urban hospitals is not as great as among rural hospitals. Therefore, any simple correlation between size and capital costs per discharge probably reflects the likely correlation between casemix and capital costs per discharge.

Proprietary hospitals had the highest Medicare capital costs per discharge of any hospital group while public hospitals had the lowest. Capital cost per discharge in proprietary hospitals was more than twice as high as that in public hospitals. Medicare capital costs per discharge were higher in teaching hospitals than in non-teaching hospitals. Medicare capital cost per discharge were usually lowest in the New England census division while they were highest in the Pacific.

The growth rate for rural hospitals exceeded the growth rate for urban hospitals by a larger margin (3.4 percentage points) than the difference for dollar levels of capital costs per hospitals (0.3 percentage points). This reflects the greater percentage decline in Medicare discharges for rural hospitals than for urban hospitals. Within each of the rural and urban classifications, the smallest hospitals had the largest increase in Medicare capital costs per discharge; partly because they had the largest percentage decline in Medicare discharges.

Public hospitals had the highest growth rates of Medicare capital costs per discharge while non-teaching hospitals had the highest average growth rate (almost twice that of major teaching hospitals). Growth rates were highest in the East and West South Central census divisions and lowest in the Middle Atlantic census division.

2.3 Depreciation Costs

Changes in depreciation costs can provide information about net capital formation in hospitals. As has already been discussed, both types of depreciation costs, buildings and fixtures and movable equipment, have increased over the four periods. This section examines the two types of depreciation in greater detail. The analysis of each type is similar to the analysis of Medicare capital costs in the previous section. The two types of depreciation are first examined separately. It was suggested in Chapter 1 that because of the uncertainty about the inclusion of capital costs in PPS, the mix of investment would shift towards an increased share for movable equipment. Results from the first section of this chapter indicated that total depreciation on buildings and fixtures increased at a compounded mean annual rate of 11.8 percent and on movable equipment at 13.9 percent (Table 2). This suggests that the mix between movable equipment and buildings and fixtures changed in favor of movable equipment with the advent of PPS. Thus, in the third part of this section, changes in the ratio of building depreciation to movable equipment depreciation is examined in detail.

2.3.1 Depreciation on Buildings and Fixtures

The distributions of building depreciation costs by dollar levels, as a share of inpatient operating costs, and per discharge were all skewed to the right during each of the four periods (Table 9). This means that a very small number of hospitals had quite large amounts of building depreciation. Although building depreciation increased each period, the growth rate of building depreciation declined each year.

Even after standardizing building depreciation by operating costs and discharges, urban hospitals had higher levels than did rural hospitals. Rural hospitals, however, had higher growth rates for the share and per discharge values. As would be expected, hospitals with more beds had higher dollar levels of building depreciation. However, after standardization by costs and discharges, there did not appear to be any striking patterns by bedsize. After standardization, proprietary hospitals had the highest levels of building depreciation. Dollar levels of building depreciation in major teaching hospitals actually declined during PPS 1. This finding might warrant further special investigation of the impact of PPS on teaching hospitals. As mentioned above, annual growth rates, while positive, continuously declined at the national level. However, many of the individual categories did not exhibit the same pattern.

TABLE 9

PERCENTILES FOR ANNUAL DEPRECIATION COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3
	DEPRECIATION OF BUILDINGS AND FIXTURES**			
100 (Maximum)	$18,950,376	$23,421,204	$22,283,508	$23,057,328
99	4,685,923	5,566,842	6,225,287	6,636,653
95	2,240,890	2,506,434	2,797,510	3,124,200
75	629,862	721,296	834,948	924,264
50 (Median)	196,740	224,382	249,306	268,704
25	66,924	74,676	82,425	88,752
5	17,780	19,599	19,411	21,204
1	7,403	6,782	6,407	7,829
0 (Minimum)	144	276	36	456
	DEPRECIATION OF BUILDINGS AND FIXTURES AS A PERCENT OF INPATIENT COSTS**			
100 (Maximum)	32.9%	39.0%	34.2%	36.8%
99	13.7	16.6	17.5	19.3
95	8.4	9.2	9.9	10.3
75	4.3	4.8	5.2	5.4
50 (Median)	2.8	3.1	3.3	3.4
25	1.8	2.0	2.1	2.1
5	0.9	0.9	1.0	1.0
1	0.3	0.4	0.4	0.4
0 (Minimum)	0.0***	0.0***	0.0***	0.0***
	DEPRECIATION OF BUILDINGS AND FIXTURES PER DISCHARGE**			
100 (Maximum)	$1,086	$1,526	$1,967	$2,218
99	470	583	694	866
95	236	298	347	423
75	106	130	157	180
50 (Median)	62	76	92	108
25	36	44	53	62
5	17	19	23	26
1	7	7	8	10
0 (Minimum)	0****	0****	0****	0****

Notes: *Only for those hospitals which had MCRs available in all four periods.
**Before reclassification or adjustment.
***Less than 0.05 percent.
****Less than $0.50.

Source: Unweighted values from Medicare Cost Reports (MCRs).

2.3.1.1 Dollar Levels of Depreciation per Hospital

The distribution of depreciation on buildings and fixtures was positively skewed during each of the four periods (Table 9). During PPS 3, the median value was 269 thousand dollars while at the 75th percentile, it was about three times higher at 924 thousand dollars. Indeed, during all four periods, the ratio of the 75th percentile to the median ranged from 3.2 to 3.4. The fact that a very small number of hospitals had quite large amounts of depreciation is even more apparent when comparing the 95th percentile to the median value. For instance, in PPS 3, the median was 269 thousand dollars while the value at the 95th percentile was 3.1 million dollars --more than ten times higher! Even within the top five percent of hospitals there was considerable disparity. Depreciation at the 99th percentile was more than twice as great as at the 95th percentile.

Depreciation on buildings and fixtures was, not surprisingly, greater in urban hospitals than in rural hospitals (Table 10). The compound average annual growth rate of depreciation was 12 percent in urban hospitals and 10.8 percent in rural hospitals. While depreciation increased year-to-year for both urban and rural hospitals, the rate of increase declined --as was the case for all hospitals. Depreciation in both urban and rural areas increased with the number of beds. However, year-to-year increases in depreciation by bedsize did not always follow the same pattern as for all hospitals.

Depreciation on buildings and fixtures was highest in voluntary hospitals and lowest in public hospitals. Public hospitals, however, had the highest average growth rate. Teaching hospitals had considerably larger depreciation costs for buildings and fixtures than did non-teaching hospitals. Even within the teaching category, major teaching hospitals had much more depreciation than did other teaching hospitals. Examination of the year-to-year changes reveals that teaching hospitals were responsible for the overall pattern of declining depreciation growth rates. Contrary to the overall pattern, most hospitals, it would appear, had their highest growth rate between PPS 1 and PPS 2. The Mountain Census division had the lowest amount of depreciation but also the highest growth rate while the mid-Atlantic Census division had the highest level and the East North Central Census division had the lowest growth rate.

2.3.1.2 Share of Inpatient Operating Costs

The distribution of building depreciation's share of inpatient operating costs was also skewed to the right during all four periods (Table 9). As with

TABLE 10

MEAN BUILDINGS AND FIXTURES DEPRECIATION PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA & PPS 3	PERCENTAGE DIFFERENCE BETWEEN Tefra And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$560,177	$642,426	$732,782	$798,616	11.8%	13.7%	13.2%	8.6%
Urban Hospitals	1,003,562	1,153,175	1,309,604	1,438,649	12.0	13.9	12.7	9.4
0 - 99 Beds	226,568	265,253	287,052	339,347	13.5	15.8	7.9	16.7
100 - 199 Beds	602,293	705,545	816,161	875,717	12.5	15.8	14.6	7.0
200 - 299 Beds	1,275,008	1,403,073	1,576,764	1,785,667	11.2	9.6	11.7	12.4
300 - 404 Beds	1,558,729	1,759,284	2,120,264	2,168,910	11.0	12.1	18.7	2.3
405 - 504 Beds	2,145,489	2,619,115	2,978,633	3,490,209	16.2	19.9	12.9	15.8
505 + Beds	3,190,876	3,522,377	4,002,416	4,349,362	10.3	9.9	12.8	8.3
Rural Hospitals	184,700	206,055	237,784	255,297	10.8	10.9	14.3	7.1
0 - 49 Beds	60,733	71,668	77,524	83,263	10.5	16.6	7.9	7.1
50 - 99 Beds	168,391	187,696	208,657	228,728	10.2	10.9	10.6	9.2
100 - 169 Beds	356,400	413,482	494,033	535,089	13.5	14.9	17.8	8.0
170 + Beds	725,277	783,500	916,308	969,250	9.7	7.7	15.7	5.6
Ownership								
State & Local Gov't	239,354	267,271	309,188	352,455	12.9	11.0	14.6	13.1
Voluntary	730,965	842,153	944,407	1,036,054	11.6	14.2	11.5	9.3
Proprietary	603,706	690,712	825,984	853,497	11.5	13.5	17.9	3.3
Teaching Status								
Non-teaching	384,444	437,553	502,075	546,095	11.7	12.9	13.8	8.4
Other Teaching	1,510,748	1,792,253	2,013,748	2,221,005	12.8	17.1	11.7	9.8
Major Teaching	2,377,565	2,371,118	2,708,781	2,985,954	7.6	-0.3	13.3	9.7
Census Division								
New England	379,208	398,542	469,631	511,372	10.0	5.0	16.4	8.5
Mid Atlantic	844,849	1,075,802	1,141,031	1,237,475	12.7	24.2	5.9	8.1
South Atlantic	528,130	657,494	744,342	831,541	15.1	21.9	12.4	11.1
East North Central	830,766	930,588	1,037,765	1,104,637	9.5	11.3	10.9	6.2
East South Central	475,900	567,334	634,411	638,989	9.8	17.6	11.2	0.7
West North Central	322,077	330,124	400,352	453,058	11.4	2.5	19.3	12.4
West South Central	491,725	573,585	669,754	745,734	13.9	15.4	15.5	10.7
Mountain	267,644	323,716	408,943	438,747	16.5	19.0	23.4	7.0
Pacific	709,043	789,764	897,831	994,293	11.3	10.8	12.8	10.2

Notes: 1. 3,548 observations per period.

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

the case of dollar levels, a few hospitals had very high shares. The 25th percentile was 2.1 percent, the median was 3.4 percent, the 75th percentile was 5.4 percent, and the 95th percentile was 10.3 percent during PPS 3.

As was the case for all hospitals, building depreciation's share of inpatient operating costs increased over the four periods for both urban and rural hospitals (Table 11). Building depreciation shares in urban hospitals were about eleven to fourteen percent higher than in rural hospitals --considerably less disparity than with dollar levels. Rural hospitals had a slightly higher average annual growth rate than urban hospitals. As was the case with Medicare capital costs, proprietary hospitals had the highest building depreciation share while public hospitals had the highest average growth rate.

Again, as was the case for Medicare capital costs, non-teaching hospitals had higher building depreciation shares than did teaching hospitals. Hospitals in the New England Census division had both the lowest building depreciation shares and average growth rate. The highest shares were in the East South Central division while the highest average growth rate was in the West South Central division.

2.3.1.3 Per Discharge

The distribution of building depreciation costs per discharge was also skewed to the right although not as much as dollar levels or share (Table 9). The median value was $108 per discharge, the 75th percentile was $180 per discharge, and the 95th percentile was $423 per discharge during PPS 3.

As was the case for dollar levels and shares, building depreciation per discharge had positive but declining growth rates over the four periods. Building depreciation per discharge was about 65 percent higher in urban hospitals than in rural hospitals (Table 12). The highest rural value by bedsize was lower than the lowest urban bedsize. Proprietary hospitals had both the highest levels and growth rates. Neither public nor voluntary hospitals had the same year-to-year pattern of growth rates as for all hospitals. Public hospitals first went down and then up whereas voluntary hospitals went up and then down.

Building depreciation per discharge in major teaching hospitals fell 16.8 percent during PPS 1. This change, as well as others involving major hospitals, indicates that teaching hospitals might have had a quite different reaction to PPS than other types of hospitals. However, as indicated in Chapter 1, the cohort of analyzed hospitals under-represents major teaching hospitals. Hence, the 16.8 percent fall in building depreciation per

TABLE 11

MEAN BUILDINGS AND FIXTURES DEPRECIATION AS A PERCENTAGE OF INPATIENT OPERATING COSTS PER SHORT-TER ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA & PPS 3	Tefra And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	3.5%	3.9%	4.2%	4.3%	7.3%	10.9%	6.7%	4.2%
Urban Hospitals	3.7	4.1	4.4	4.6	7.0	9.9	5.9	5.3
0 - 99 Beds	3.5	4.0	4.2	4.6	9.5	15.5	3.6	9.3
100 - 199 Beds	3.9	4.3	4.6	4.8	6.7	9.5	6.3	4.3
200 - 299 Beds	4.2	4.4	4.6	5.0	5.4	4.4	5.1	6.7
300 - 404 Beds	3.7	4.0	4.4	4.2	4.4	7.6	10.8	-5.1
405 - 504 Beds	3.4	3.9	4.2	4.5	9.2	13.6	6.2	8.0
505 + Beds	3.0	3.4	3.6	3.9	8.5	12.0	7.7	5.9
Rural Hospitals	3.3	3.7	4.0	4.1	7.3	11.5	6.8	3.5
0 - 49 Beds	3.1	3.6	3.8	3.9	7.2	13.5	5.5	2.6
50 - 99 Beds	3.5	3.7	4.0	4.2	6.4	7.8	7.0	4.4
100 - 169 Beds	3.4	4.0	4.4	4.7	10.9	17.5	9.3	6.0
170 + Beds	3.5	3.6	4.0	3.9	3.6	4.2	11.3	-4.8
Ownership								
State & Local Gov't	3.1	3.5	3.7	3.9	7.7	11.0	6.1	6.0
Voluntary	3.4	3.7	4.0	4.2	6.7	9.8	6.2	4[illegible]
Proprietary	4.7	5.4	5.7	5.9	7.5	13.9	5.7	2.[illegible]
Teaching Status								
Non-teaching	3.5	3.9	4.2	4.4	7.3	11.0	6.7	4.2
Other Teaching	3.3	3.8	4.1	4.2	7.5	12.4	7.1	2.9
Major Teaching	2.8	2.6	2.7	3.1	2.7	-7.4	1.1	14.4
Census Division								
New England	2.5	2.6	2.8	2.7	2.9	5.5	5.5	-2.2
Mid Atlantic	3.3	4.1	4.0	3.9	5.6	21.8	-2.7	-2.3
South Atlantic	3.5	4.0	4.2	4.4	8.0	13.8	6.8	3.5
East North Central	3.7	4.0	4.3	4.3	5.2	8.8	5.8	0.9
East South Central	4.3	4.8	5.1	5.4	7.5	10.1	7.1	5.3
West North Central	3.1	3.5	3.6	3.7	6.1	11.0	3.4	3.8
West South Central	3.7	4.2	4.7	5.1	10.6	12.7	11.2	8.0
Mountain	3.0	3.4	3.7	3.8	7.4	12.4	6.8	3.0
Pacific	3.2	3.5	3.7	3.9	6.5	7.7	4.5	7.1

Notes: 1. 3,450 observations per period (2,970 in TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8) For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

TABLE 12

MEAN BUILDINGS AND FIXTURES DEPRECIATION PER DISCHARGE PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA AND PPS 3	PERCENTAGE CHANGE BETWEEN Tefra And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$87	$107	$131	$154	18.8%	20.4%	19.8%	16.0%
Urban Hospitals	113	137	165	196	18.2	19.0	18.8	16.7
0 - 99 Beds	90	121	144	187	24.6	29.9	17.8	25.9
100 - 199 Beds	113	139	171	194	17.9	20.3	20.7	12.8
200 - 299 Beds	143	157	182	218	14.2	9.3	15.2	18.0
300 - 404 Beds	113	135	173	178	15.1	17.9	24.7	2.6
405 - 504 Beds	122	148	175	212	18.6	19.8	16.6	19.3
505 + Beds	106	128	153	180	17.5	18.5	17.7	16.5
Rural Hospitals	67	83	102	119	19.0	20.8	20.8	15.5
0 - 49 Beds	65	83	100	119	20.1	24.4	18.8	17.1
50 - 99 Beds	67	79	97	112	16.9	15.5	20.6	14.7
100 - 169 Beds	67	88	113	134	22.9	26.9	24.7	17.2
170 + Beds	78	86	110	115	12.8	9.4	24.9	4.0
Ownership								
State & Local Gov't	64	80	96	116	19.8	21.3	18.4	19.6
Voluntary	90	107	130	151	17.3	17.7	19.2	14.9
Proprietary	131	166	206	241	20.3	24.0	21.4	15.6
Teaching Status								
Non-teaching	83	102	125	148	19.3	21.2	20.3	16.4
Other Teaching	114	140	166	192	17.5	21.0	16.7	14.7
Major Teaching	150	127	145	170	4.1	-16.8	13.3	15.9
Census Division								
New England	72	74	89	94	8.7	2.3	18.5	5.2
Mid Atlantic	100	133	140	153	14.2	29.0	4.7	9.0
South Atlantic	80	103	125	146	20.0	25.5	18.6	15.8
East North Central	103	119	144	165	15.8	14.5	19.5	13.4
East South Central	84	103	129	144	18.2	20.8	22.4	11.3
West North Central	73	91	109	125	17.9	22.5	17.5	13.8
West South Central	82	99	130	165	23.2	19.1	26.9	23.6
Mountain	73	92	116	131	19.7	23.4	23.0	12.6
Pacific	111	135	159	193	18.4	19.7	15.9	19.7

Notes: 1. 3,450 observations per period (2,970 in TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

discharge may be an artifact of a biased sample. Hospitals in the New England census division had both the lowest building depreciation per discharge and the lowest growth rate while the Pacific census division had the highest levels.

2.3.2 Depreciation on Movable Equipment

The distributions of movable equipment depreciation costs by dollar levels, as a share of inpatient operating costs, and per discharge were all skewed to the right during each of the four periods (Table 13). This means that a very small number of hospitals had quite large amounts of movable equipment depreciation. Although movable equipment depreciation increased each period, the growth rate of movable equipment depreciation declined each year.

Even after standardizing movable equipment depreciation by operating costs and discharges, urban hospitals had higher levels than did rural hospitals. Rural hospitals, however, had higher growth rates for dollar levels per hospital, the share, and per discharge values. As would be expected, hospitals with more beds had higher dollar levels of movable equipment depreciation. After standardization by costs and discharges, unlike building depreciation, movable equipment depreciation in rural hospitals increased with bedsize. As discussed in Section 2.2, this association probably reflects casemix differences among rural hospitals. After standardization, proprietary hospitals had the highest levels of movable equipment depreciation while public hospitals had the highest average growth rates. Teaching hospitals, had the highest dollar levels of movable equipment depreciation. Non-teaching hospitals, however, had higher average growth rates of movable equipment depreciation than did teaching hospitals. As mentioned above, annual growth rates, while positive, continuously declined at the national level. However, many of the individual categories did not exhibit the same pattern.

2.3.2.1 Dollar Levels of Depreciation per Hospital

The distribution of movable equipment depreciation was skewed to the right during each of the four periods (Table 13). Except for the very highest percentiles, dollar levels of movable equipment depreciation were just a little lower than dollar levels of building depreciation. The median value of movable equipment depreciation was 260 thousand dollars, the 75th percentile was 801 thousand dollars, and the 95th percentile was 2.5 million dollars during PPS 3.

TABLE 13

PERCENTILES FOR ANNUAL DEPRECIATION COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3
	DEPRECIATION OF MOVABLE EQUIPMENT**			
100 (Maximum)	$9,453,096	$9,006,084	$8,530,596	$9,479,808
99	3,211,816	3,831,998	4,421,789	4,823,751
95	1,597,867	1,949,089	2,209,373	2,487,396
75	507,180	602,028	707,580	801,813
50 (Median)	169,404	199,596	224,964	259,938
25	59,376	67,176	75,156	83,898
5	18,019	19,808	20,177	21,504
1	7,576	7,262	7,189	5,301
0 (Minimum)	324	192	36	96
	DEPRECIATION OF MOVABLE EQUIPMENT AS A PERCENTAGE OF INPATIENT COSTS**			
100 (Maximum)	15.8%	36.3%	35.6%	22.5%
99	7.4	9.1	8.8	9.2
95	4.8	5.5	5.9	6.3
75	3.1	3.6	3.9	4.1
50 (Median)	2.5	2.8	3.1	3.3
25	1.8	2.1	2.3	2.5
5	1.1	1.1	1.2	1.2
1	0.5	0.3	0.2	0.2
0 (Minimum)	0.0***	0.0***	0.0***	0.0***
	DEPRECIATION OF MOVABLE EQUIPMENT PER DISCHARGE**			
100 (Maximum)	$550	$858	$1,002	$1,020
99	235	286	344	381
95	139	176	212	250
75	80	100	125	147
50 (Median)	55	69	85	100
25	37	45	57	68
5	20	23	27	31
1	10	7	5	5
0 (Minimum)	0****	0****	0****	0****

Notes: *Only for those hospitals which had MCRs available in all four periods.
**Before reclassification or adjustment.
***Less than 0.05 percent.
****Less than $0.50.

Source: Unweighted values from Medicare Cost Reports (MCRs).

Depreciation on movable equipment was greater in urban hospitals than in rural hospitals (Table 14). Unlike depreciation on buildings and fixtures, however, the compound average annual growth rate of movable equipment depreciation was lower in urban hospitals (13.4 percent) than in rural hospitals (14.8 percent). While movable equipment depreciation increased year-to-year for both urban and rural hospitals, the rate of increase declined --as was the case for all hospitals. Depreciation in both urban and rural areas increased with the number of beds. Among rural hospitals, the average growth rate of movable equipment depreciation was positively correlated with bedsize. Year-to-year increases in depreciation by bedsize, however, did not always follow the same pattern as for all hospitals.

Depreciation on movable equipment was highest in voluntary hospitals and lowest in public hospitals. Proprietary hospitals had the highest average growth rate. Teaching hospitals had considerably larger depreciation costs for movable equipment than did non-teaching hospitals. Even within the teaching category, major teaching hospitals had much more depreciation than did other teaching hospitals. Non-teaching hospitals had the highest average growth rate of movable equipment depreciation. The West North Central had both the lowest amount of depreciation and the lowest growth rate while mid-Atlantic and East North Central hospitals had the highest level and the East South Central Census division had the highest growth rate.

2.3.2.2 Share of Inpatient Operating Costs

The distribution of movable equipment depreciation's share of inpatient operating costs was also skewed to the right during all four periods (Table 13). The 25th percentile was 2.5 percent, the median was 3.3 percent, the 75th percentile was 4.1 percent, and the 95th percentile was 6.3 percent during PPS 3 -- the gap between the 75th and 95th percentiles was not as great as for building depreciation.

As was the case for all hospitals, movable equipment depreciation's share of inpatient operating costs increased over the four periods for both urban and rural hospitals (Table 15). Movable equipment depreciation shares in urban hospitals were just slightly higher than in rural hospitals. Rural hospitals had a slightly higher average annual growth rate than urban hospitals. Among the rural hospitals, movable equipment depreciation shares and their growth rate increased with bedsize. As discussed in Section 2.2.4, this association probably reflects casemix differences rather the number of beds. As was the case with Medicare capital costs, proprietary hospitals had the highest movable equipment depreciation share while public hospitals had the highest average growth rate.

TABLE 14

MEAN MOVABLE EQUIPMENT DEPRECIATION PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	PERCENTAGE DIFFERENCE BETWEEN TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$427,769	$501,472	$572,766	$648,166	13.9%	15.9%	13.3%	12.4%
Urban Hospitals	751,194	869,321	993,678	1,121,814	13.4	14.6	13.4	12.1
0 - 99 Beds	150,094	172,787	203,716	231,538	14.4	14.1	16.5	12.8
100 - 199 Beds	418,240	486,940	574,317	644,583	14.4	15.2	16.5	11.5
200 - 299 Beds	865,187	1,039,371	1,177,123	1,321,364	14.1	18.3	12.4	11.6
300 - 404 Beds	1,208,902	1,324,270	1,540,765	1,710,087	11.6	9.1	15.1	10.4
405 - 504 Beds	1,809,825	2,070,615	2,325,817	2,579,307	11.8	13.5	11.6	10.3
505 + Beds	2,652,190	3,069,503	3,408,538	3,925,950	13.1	14.6	10.5	14.1
Rural Hospitals	152,169	181,434	211,610	237,075	14.8	17.6	15.4	11.4
0 - 49 Beds	46,945	52,425	59,342	65,879	11.3	11.0	12.4	10.5
50 - 99 Beds	127,941	146,609	166,406	185,790	12.4	13.6	12.7	11.0
100 - 169 Beds	301,682	357,090	420,727	463,335	14.3	16.9	16.4	9.6
170 + Beds	633,227	776,188	908,319	1,034,220	16.4	20.4	15.7	13.0
Ownership								
State & Local Gov't	245,335	279,023	309,462	357,735	12.6	12.9	10.4	14.5
Voluntary	536,086	627,176	713,852	809,849	13.8	15.7	12.9	12.6
Proprietary	385,944	471,313	571,787	625,809	16.1	20.0	19.3	9.0
Teaching Status								
Non-teaching	279,293	333,751	386,795	434,696	14.7	17.8	14.7	11.7
Other Teaching	1,137,730	1,325,038	1,482,851	1,695,845	13.3	15.2	11.3	13.4
Major Teaching	2,192,177	2,410,705	2,621,923	2,810,784	8.3	9.5	8.4	7.0
Census Division								
New England	377,181	429,322	507,444	576,613	14.1	12.9	16.7	12.8
Mid Atlantic	568,074	625,461	771,603	902,429	15.4	9.6	21.0	15.7
South Atlantic	499,026	601,880	704,267	808,517	16.1	18.7	15.7	13.8
East North Central	585,711	663,487	723,793	817,944	11.1	12.5	8.7	12.2
East South Central	303,159	362,107	446,759	534,017	18.9	17.8	21.0	17.8
West North Central	250,384	291,810	320,488	347,875	11.0	15.3	9.4	8.2
West South Central	354,806	449,677	514,363	565,931	15.6	23.7	13.4	9.6
Mountain	263,761	324,256	367,732	423,749	15.8	20.6	12.6	14.2
Pacific	565,257	632,975	721,548	805,355	11.8	11.3	13.1	11.0

Notes: 1. 2,800 observations per period.

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8). For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

TABLE 15

MEAN MOVABLE EQUIPMENT DEPRECIATION AS A PERCENTAGE OF INPATIENT OPERATING COSTS PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	2.6%	3.0%	3.3%	3.4%	9.0%	13.5%	8.3%	5.1%
Urban Hospitals	2.7	3.0	3.3	3.5	8.6	12.9	7.6	5.4
0 - 99 Beds	2.5	2.9	3.0	3.2	9.0	14.3	6.5	6.4
100 - 199 Beds	2.8	3.0	3.3	3.5	8.3	9.7	9.1	6.1
200 - 299 Beds	2.8	3.3	3.6	3.7	10.1	17.8	7.9	4.7
300 - 404 Beds	2.7	2.9	3.2	3.3	6.7	9.7	9.7	0.6
405 - 504 Beds	2.7	3.1	3.3	3.4	7.7	15.3	4.4	3.3
505 + Beds	2.9	3.2	3.3	3.6	7.3	10.7	4.3	7.1
Rural Hospitals	2.6	3.0	3.2	3.4	9.2	13.9	9.1	4.5
0 - 49 Beds	2.4	2.7	2.9	3.1	7.6	10.5	6.8	5.6
50 - 99 Beds	2.6	3.0	3.3	3.4	9.8	15.9	8.6	5.1
100 - 169 Beds	2.9	3.3	3.8	3.9	10.2	14.5	13.5	2.6
170 + Beds	2.9	3.6	4.0	4.2	12.0	20.9	9.5	5.6
Ownership								
State & Local Gov't	2.6	2.9	3.2	3.4	9.4	12.9	8.6	6.7
Voluntary	2.5	2.9	3.1	3.3	8.5	14.0	6.3	5.0
Proprietary	3.2	3.5	4.0	4.1	8.9	10.5	13.1	3.0
Teaching Status								
Non-teaching	2.6	3.0	3.3	3.5	9.1	13.8	8.6	5.0
Other Teaching	2.6	2.9	3.1	3.3	8.0	11.3	7.6	5.3
Major Teaching	2.4	2.7	2.7	2.8	4.3	8.6	0.7	3.6
Census Division								
New England	2.1	2.4	2.6	2.8	8.7	12.4	9.2	4.5
Mid Atlantic	2.2	2.5	2.8	3.1	10.9	11.8	12.0	9.1
South Atlantic	2.7	3.1	3.4	3.6	10.0	15.3	8.9	5.7
East North Central	2.4	2.7	3.0	3.2	9.0	12.1	9.1	5.8
East South Central	2.7	3.5	4.1	3.9	11.9	23.0	16.0	-3.5
West North Central	2.5	2.9	3.0	3.2	7.3	12.4	4.9	4.5
West South Central	2.9	3.4	3.6	4.0	10.0	14.6	7.1	8.4
Mountain	2.9	3.3	3.4	3.5	6.3	13.7	2.4	2.9
Pacific	2.7	2.8	3.1	3.2	6.1	3.3	10.0	5.1

Notes: 1. 2,690 observations per period (2,358 in TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8).
For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in co[illegible] 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

Again, as was the case for Medicare capital costs, non-teaching hospitals had higher movable equipment depreciation shares than did teaching hospitals. Hospitals in the New England census division had the lowest movable equipment depreciation shares and while the Pacific census division had the lowest average growth rate. The highest shares were in the East and West South Central census divisions while the highest average growth rate was in the East South Central census division.

2.3.2.3 Per Discharge

The distribution of movable equipment depreciation costs per discharge was also skewed to the right (Table 13). The median value was $100 per discharge, the 75th percentile was $147 per discharge, and the 95th percentile was $250 per discharge during PPS 3.

As was the case for dollar levels and shares, movable equipment depreciation per discharge had positive but declining growth rates over the four periods. Movable equipment depreciation per discharge was about 50 percent higher in urban hospitals than in rural hospitals with the gap becoming slightly narrower over the four periods (Table 16). The highest rural value by bedsize was lower than the lowest urban bedsize. Among the rural hospitals, movable equipment depreciation per discharge increased with bedsize. Again, this association probably reflects casemix differences rather the number of beds. There did not seem to be any pattern by bedsize in the average annual growth rates or in the year-to-year growth rates.

Proprietary hospitals had the highest levels of movable equipment depreciation while public hospitals had the highest growth rates. Proprietary hospitals did not had the same year-to-year pattern of growth rates as for all hospitals --the largest annual increase for proprietary hospitals was during PPS 2. Unlike building depreciation, movable equipment depreciation per discharge in major teaching hospitals never declined. The growth rate of movable equipment depreciation in non-teaching hospitals was nearly twice as large as in major teaching hospitals. Hospitals in the New England census division had both the lowest movable equipment depreciation per discharge and the lowest growth rate. The Pacific census division had the highest levels and the East South Central census division had the highest growth rate.

2.3.3 Comparison of Building to Movable Equipment Depreciation

In this section, depreciation of buildings and fixtures is compared to depreciation of movable equipment. The comparison is conducted both for all

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TABLE 16

MEAN MOVABLE EQUIPMENT DEPRECIATION PER DISCHARGE PER SHORT-TERM ACUTE-CARE HOSPITAL IN NON-WAIVERED STATES, BY YEAR*

						PERCENTAGE CHANGE BETWEEN		
	TEFRA	PPS 1	PPS 2	PPS 3	Annual Percent Change Between TEFRA And PPS 3	TEFRA And PPS 1	PPS 1 And PPS 2	PPS 2 And PPS 3
All Hospitals	$65	$81	$99	$117	19.8%	22.3%	20.4%	16.7%
Urban Hospitals	81	99	120	141	18.5	20.0	19.3	16.2
0 - 99 Beds	66	80	103	126	21.4	18.8	24.7	20.8
100 - 199 Beds	81	98	117	137	17.3	18.0	18.6	15.4
200 - 299 Beds	88	115	135	157	19.4	26.8	16.4	14.8
300 - 404 Beds	82	101	123	139	17.4	20.1	19.8	12.3
405 - 504 Beds	93	115	135	156	17.2	21.1	15.9	14.6
505 + Beds	100	116	136	158	15.1	14.9	15.3	15.2
Rural Hospitals	52	65	82	97	20.9	23.5	22.4	16.8
0 - 49 Beds	49	62	77	93	21.5	23.7	21.9	18.9
50 - 99 Beds	50	63	79	91	20.1	23.4	22.0	14.7
100 - 169 Beds	59	74	94	110	21.0	22.6	24.4	15.9
170 + Beds	64	83	102	120	20.6	25.5	20.6	15.8
Ownership								
State & Local Gov't	53	67	83	101	21.5	22.8	22.0	19.7
Voluntary	65	81	97	113	18.5	21.9	17.8	15.9
Proprietary	88	106	137	159	19.8	19.1	25.6	14.9
Teaching Status								
Non-teaching	61	77	95	112	20.5	23.5	21.3	16.8
Other Teaching	85	102	122	143	17.3	17.8	18.2	16.1
Major Teaching	115	134	142	158	10.6	15.5	5.1	11.1
Census Division								
New England	63	68	84	96	14.3	8.6	20.8	13.4
Mid Atlantic	67	80	97	119	19.2	17.9	19.4	20.4
South Atlantic	63	81	99	119	21.1	24.6	20.2	18.4
East North Central	66	80	97	113	17.7	18.3	19.6	15.3
East South Central	49	70	93	101	24.0	35.6	28.1	8.3
West North Central	59	74	87	103	19.0	23.0	16.7	17.2
West South Central	63	80	99	123	22.5	23.5	21.5	22.3
Mountain	64	81	102	116	19.8	23.9	22.4	13.0
Pacific	90	103	126	146	16.1	14.1	19.7	14.6

Notes: 1. 2,690 observations per period (2,358 in TEFRA).

2. Reported values are unweighted means of individual hospital ratios (except for columns 5-8).
For each line, column 5's value equals ln(PPS3/TEFRA)/3. For each line, values in columns 6-8 equal ln(End period/Beginning period).

Text Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).

hospitals and as stratified by hospital characteristic. The focus of these comparisons is how the ratio of building depreciation to movable equipment depreciation changed over the four periods. Values presented below were calculated by dividing values presented in Table 10 by values in Table 14.

Examining, first, all hospitals, depreciation on buildings and fixtures was greater than depreciation on movable equipment in all four periods. The difference between the two levels, however, narrowed over the four periods. During TEFRA, depreciation on buildings and fixtures was 31 percent higher than depreciation on movable equipment. By PPS 3, the difference between the two had narrowed to 23 percent. This indicates that investment in movable equipment was substituted for investment in buildings and fixtures.

Examining the difference between building and movable equipment depreciation by hospital characteristic also revealed that levels of the two types of depreciation became closer. For instance, in rural hospitals, building depreciation was 21 percent higher than movable equipment depreciation during TEFRA. By PPS 3, building depreciation was only 8 percent higher than movable equipment depreciation.

Convergence between the two types of depreciation, however, did not always occur. Both public and teaching hospitals had little overall change in the ratio of building to movable equipment depreciation over the four periods. Further, analysis of the ratios on a year-to-year basis revealed considerable fluctuation and reversal of direction of change. For instance, the apparent stability of the ratio of building to movable equipment depreciation for both public and teaching hospitals was masked by considerable inter-period change. This suggests that, in some instances, PPS may be affecting the long-term mix of physical assets. In other cases, PPS may be causing year-to-year fluctuation with little impact on the long-term mix of building and movable equipment.

The rest of this section reports detailed results of comparing building to movable equipment depreciation by hospital characteristic. Both types of depreciation were substantially higher in urban hospitals than in rural hospitals. The ratio of building to movable equipment depreciation was also higher in urban hospitals than in rural hospitals. The ratio of building to movable equipment depreciation in urban hospitals was 1.34 in TEFRA (building depreciation 34 percent higher than movable equipment depreciation). By PPS 3, the ratio between building and movable equipment depreciation had fallen to 1.28. For rural hospitals, however, the ratio fell from 1.21 in TEFRA to 1.08 in PPS 3. For rural hospitals with 170 or more beds, the ratio was 1.15 during TEFRA, 1.01 during both PPS 1 and 2, and fell to .94 during PPS 3. What do these differences mean? Do they reflect reactions to PPS? If so, why do rural hospitals seem to have reacted more quickly to PPS than urban hospitals? Was it because urban hospitals undertook larger construction projects that had more lead and construction time than construction projects for rural hospitals? Or were urban hospitals in better financial condition than rural hospitals before PPS and therefore able to continue their construction projects? Or, even before the advent of PPS, were rural hospitals already planning to change their physical asset mix?

PPS apparently did not have any impact on the mix of physical assets in public hospitals. Public hospitals, regardless of period, had about the same level of depreciation for both categories. Public hospitals also had the lowest amount of both types of depreciation while voluntary hospitals had the largest amount of both types. Proprietary hospitals, other the other hand, had the largest decline in the ratio of building to movable equipment depreciation. Their ratio fell from 1.56 during TEFRA to 1.36 during PPS 3.

In contrast to non-teaching hospitals which had a pattern of declining ratios of building to movable equipment depreciation, the ratios for teaching hospitals were slightly lower during PPS 3 than during TEFRA. Inspection of the end-points, however, is somewhat misleading in the case of teaching hospitals. Year-to-year changes in the ratio of building to movable equipment depreciation were often substantial with reversals in the direction of change.

In the Mountain and West North Central census divisions, the ratio of building to movable equipment depreciation was higher during PPS 3 than during TEFRA. The New England and East South Central census divisions experienced the largest percentage declines in the ratio of building to movable equipment. As in the case of other hospital characteristics, there was considerable year-to-year fluctuation in the ratios of some census divisions.

REFERENCES

Anderson, Gerard and Paul B. Ginsburg. "Prospective Capital Payments to Hospitals," Health Affairs 2:3 (Fall 1983), 52-63.

Cohodes, Donald R. and Brian M. Kinkead. Hospital Capital Formation in the 1980s. Baltimore: The Johns Hopkins University Press, 1984.

Cromwell, Jerry, Gerard Wedig, and Frank A. Sloan. Medicare Medicaid Payment Policies and Hospital Capital Formation. Final Report for Cooperative Agreement No. 18-C-98267/1-02 (from HCFA). Chestnut Hill, MA: Center for Health Economics Resesearch, December 23, 1985.

Federal Reserve Bank of St. Louis. Monetary Trends (August 1988).

Gaynor, Martin and Ashley Stone. The Effect of Medicare's Prospective Payment System on Hospital Capital Investment. Year One Technical Report for Contract No. 500-85-0015 (from HCFA). Needham, MA: Health Economics Research, Inc., May 8, 1987.

Guterman, Stuart and Allen Dobson. "Impact of the Medicare Prospective Payment System for Hospitals," Health Care Financing Review 7:3 (Spring 1986), 97-114.

Hillman, Bruce J., et al. Diffusion of Magnetic Resonance Imaging into Clinical Practice. Rand Report R-3392-HHS. Santa Monica, CA: September 1986.

Kinney, Eleanor D. and Bonnie Lefkowitz. "Capital Cost Reimbursement to Community Hospitals under Federal Health Insurance Programs," Journal of Health Politics, Policy and Law 7:3 (Fall 1982), 648-666.

Luft, Harold S., et al. "The Role of Specialized Clinical Services in Competition Among Hospitals," Inquiry 23:1 (Spring 1986), 83-94.

Propspective Payment Assessment Commission. Technical Appendixes to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services. April 1, 1986; April 1, 1987; and March 1, 1988.

Propspective Payment Assessment Commission. Medicare Prospective Payment and the American Health Care System, Report to the Congress. June 1988.

Sloan, Frank A., Joseph Valvona, and Mahmud Hassan. "Cost of Capital to the Hospital Sector," Journal of Health Economics 7:1 (March 1988), 25-45.

U.S. Bureau of the Census. Statistical Abstract of the United States: 1987 and 1988, 107th and 108th editions. Washington, DC.

Valvona, Joseph and Frank A. Sloan. "Hospital Profitability and Capital Structure: A Comparative Analysis," Health Services Research 23:3 (August 1988), 343-357.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES -- HOSPITAL INVESTMENT TRENDS UNDER THE FEDERAL PROSPECTIVE PAYMENT SYSTEM

Draft Final Report

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EXECUTIVE SUMMARY

One of the well-springs of economic growth is investment in physical assets such as buildings and equipment. The hospital industry, however, is an industry in which investment has had a mixed reception in the last fifty years. While regarded as vital for the nation's health, hospital investment has also been regarded as one of the leading causes of inpatient expenditure inflation. The investment decisions of hospitals may have been affected by the establishment of the federal Prospective Payment System (PPS). This study examines the net investment of hospitals during the first years of PPS.

The cost-based reimbursement mechanism for capital costs of hospitals has yet to be changed by PPS. However, the implementation of PPS may have indirectly affected the investment decisions of hospitals by affecting the determinants of investment and, thus, the level of investment. To help assess the relative importance of the impact of PPS upon hospital investment, the following factors which could affect the scale of hospital investment were considered: (1) the lead times associated with large-scale construction; (2) the uncertainty surrounding the ultimate inclusion of capital costs under PPS; (3) the impact of PPS DRGs upon hospital inpatient volume and profit; (4) the influence of cost-based reimbursement of capital costs on investment; (5) changes in the relative cost of capital, i.e., the price per unit of capital facing hospitals; and (6) miscellaneous factors both economy-wide and those specific to the hospital industry.

Some of the factors listed above could raise hospital demand for capital while others could decrease it. While unequivocal predictions of the net impact of PPS on the overall demand for physical assets cannot be made, it is likely that the net impact was to increase it. It is also likely that the listed factors affected both the level and mix of physical assets acquired by hospitals since the implementation of PPS.

This study used data primarily from Medicare Cost Reports (MCRs) in the four Medicare payment periods TEFRA (FY1983) through PPS-3 (FY1986). The file

included all nonfederal, short-term, acute-care hospitals (in non-waivered states) for which a MCR was received. Relative to the universe of hospitals, the 3,795 analyzed hospitals under-represented large urban hospitals, major teaching hospitals, and proprietary hospitals. Therefore, net investment was also analyzed by controlling for hospital characteristics.

Mean growth rates were used to describe the growth of the nation's aggregate stock of net fixed assets in hospitals. Since the emphasis of this report was, however, on net investment of the typical hospital, median values were used to characterize the typical hospital. Medians were used instead of means because distributions of growth rates of individual hospitals were highly skewed.

Mean values of net fixed assets per hospital grew from ten million to 13.1 million dollars between TEFRA and PPS-3 (dollar values were not deflated). These means imply that the nation's stock of hospital net fixed assets grew 13.5 percent during the first year of PPS, 7.4 percent during PPS-2, and 8.1 percent during PPs-3. Growth rates of net fixed assets for individual hospitals reveal that there was considerable diversity of investment experience among hospitals. In any given year the typical (median) hospital had an annual growth rate of net fixed assets of less than one percent. Median values thus indicate that the typical hospital had little if any growth of real net assets in any given year since the implementation of PPS. Growth rates based on the means of net fixed assets, on the other hand, indicated that there have been increases in the national stock of real net assets during this period. These two findings are not necessarily contradictory given that large-scale construction is, for individual hospitals, very episodic and concentrated in a few hospitals. Mean growth rates over the entire analyses period were also calculated for each hospital. These average growths rates indicated that the typical hospital had a higher growth rate than implied by the single period growth rates. This implies that in order to obtain a clearer picture of the investment activity of the typical hospital, it is necessary to use several years of data.

In addition to examining the distributions of individual hospitals growth rates, medians were computed by hospital characteristic. Between TEFRA

and PPS-3 the typical urban hospital had a growth rate of net assets ranging from two to three percent annually while the typical rural hospital had declines of about one percent annually in net assets. In general, larger hospitals had higher growth rates of net assets. Only the smallest rural hospitals had negative growth rates in selected years although the three period average median growth rates were slightly above zero percent. Among rural hospitals, "Rural Referral Center" (RRC) hospitals had the highest growth rate of net assets. Sole Community Hospitals (SCH) had higher growth rates in conjunction with RRC status than without RRC status. Urban hospitals which had disproportionate shares of poor patients had higher asset growth than other urban hospitals. Rural hospitals which had high shares of poor patients had the lowest growth rates of net assets.

Hospitals that the highest occupancy rates during PPS-1 had higher growth rates of net assets than hospitals in the lowest quartiles. This indicates that hospitals with "excess" capacity were not investing as much as hospitals that were operating closer to full capacity. During individual payment periods, the typical hospital operated by state and local governments (public) experienced negative growth rates of net assets whereas typical voluntary and proprietary hospitals had positive growth rates with proprietary hospitals having had the highest growth rates. Teaching hospitals had much higher growth rates of net assets than did non-teaching hospitals.

A subset of 2,239 hospitals with AHA capital expenditures data was also analyzed in order to shed light on the relative reaction speed of the building and equipment components of gross investment as well as indicating the composition of gross investment. Aggregate gross investment for the 2,239 hospitals barely changed as it ranged from 4.4 to 4.5 billion dollars between TEFRA and PPS-2. This implies, given inflation, that real investment fell over these three periods. While the aggregate gross investment remained relatively unchanged over the three periods, there were considerable year-to-year changes in its composition. The share of total equipment fell from 38 percent during TEFRA to 30 percent during PPS-1 and then rose to 43.8 percent during PPS-2. The other sizable change was in construction in progress which increased at first and then fell substantially.

AHA data also indicated that spending on large-scale construction projects had a lagged response to the implementation PPS. Spending on equipment by hospitals, however, was sensitive to hospitals' current economic health.

1.0 INTRODUCTION

One of the well-springs of economic growth is investment in physical assets such as buildings and equipment. There are industries, however, in which investment is not an unmixed blessing. For example, natural monopolies (e.g., the generation and transmission of electricity) are regulated in order to prevent "wasteful duplication" of facilities. In other industries capital formation per se is not a problem, however, side effects associated with it, such as pollution, may be of great concern.

Investment in the hospital industry has had a mixed reception in the last fifty years. While regarded as vital for the nation's health, hospital investment has also been regarded as one of the leading causes of inpatient expenditure inflation. Bice (1984), in outlining the role of the federal government in health care planning and regulation, noted that the physical fitness of WW II military inductees raised Congressional concern about the adequacy of the nation's medical care system. Thus, after WW II, hospital investment was promoted by the Hill-Burton Act (Hospital Survey and Construction Act of 1946, PL 79-725) in order to increase public access to hospital services. Further, as noted by Kelly (1984) and others, new hospital-based technology is often associated with better quality of care.

After the implementation of the Medicare and Medicaid programs, in contrast, investment was believed to be an important source of hospital expenditure inflation. This belief was partly responsible for the passage of the National Health Planning and Resources Development Act of 1974 (PL 93-641). Among its many provisions, PL 93-641 required states to establish Certificate-of-Need (CON) programs for the purpose of regulating the amount and composition of investment in hospital facilities and services. While capital expenditures are still regarded as an important source of inflation of hospital expenditures (e.g., Kelly, 1984) federal funding for PL 93-641 has been discontinued and states have been allowed to dismantle their CON programs.

In addition to direct regulation of capital expenditures, the federal government can affect hospital capital formation by its Medicare inpatient reimbursement mechanism. Prior to the implementation of the federal

Prospective Payment System (PPS), individual hospitals received Medicare reimbursement based on their own costs of providing inpatient services. The characteristics of this cost-based reimbursement mechanism may have affected the demand for capital by hospitals (Wedig, Hassan, and Sloan, forthcoming). The continued cost-based reimbursement of hospital capital costs in conjunction with the use of DRGs as the basis for reimbursing Medicare inpatient services also has an affect on the demand for capital. To help assess whether PPS has changed the rate of capital formation, this study presents evidence on net fixed assets and investment since the introduction of PPS.

The establishment of a federal prospective payment system occurred during the last phases of a deep recession that was marked by unusually high interest rates and at a time of upheaval in hospital, physician, and health insurance markets. HMOs gained new vigor while the numbers of physicians per capita increased to levels not observed for over 50 years. Young physicians found it more difficult to establish new practices than their predecessors. The federal government changed reimbursement rules to encourage HMO enrollment of Medicare beneficiaries. These and other changes in health care markets make it difficult to attribute changes in hospital behavior solely to PPS. While this study cannot establish causal relationships, it indicates how PPS might affect hospital capital formation and thus provides guidelines for interpreting the evidence.

Prior studies of hospital investment are briefly discussed in Section 1.1 of this chapter. Theoretical considerations and predictions are outlined in Section 1.2. The characteristics of the database employed in this study are described in Section 1.3. The results of the analysis are presented in Chapter 2. Finally, difficulties in interpreting growth rates are discussed in the Appendix.

1.1 Prior Studies

Until recently, there was little direct concern about the impact of capital reimbursement mechanisms on hospital investment. Instead, the

indirect impact of capital on the overall cost of inpatient services received the most attention. Indeed, there has been much research on the impact of certificate-of-need laws and similar programs on the acquisition of physical capital and the subsequent impact on inpatient costs. The studies on the impact of capital reimbursement mechanisms, cited below, present data on capital formation prior to PPS. Thus, this study is the only one that focuses on the actual behavior of capital formation since the inception of PPS.

There have been three major lines of investigation of capital formation. First has been the impact of cost-based reimbursement on the growth of total hospital capital costs and the consequent expenditures by Medicare for its share of the capital costs (Kinney and Lefkowitz, 1982; Anderson and Ginsburg, 1983; Cohodes and Kinkead, 1984; Cromwell, Wedig, and Sloan, 1985; and Wedig, Hassan, and Sloan, forthcoming). The focus of the first three articles was on policy options for changing the capital reimbursement mechanism. Wedig, Hassan, and Sloan (forthcoming) have written an important article that delineates a sound theoretical approach for analyzing hospital investment. Section 1.2 of our study draws extensively upon their paper. A second set of studies has drawn implications of cost-based reimbursement on capital structure (Wedig, et al., 1988; Sloan, et al., 1988; Valvona and Sloan, 1988). These empirical articles focus primarily on financial variables such as the debt/asset ratio and the return on assets. While these articles are important, they have limited applicability to the focus of this investigation. A third area has been the effect of financing mechanisms on the acquisition of capital assets (Cohodes and Kinkead, 1984). To a large extent the Cohodes and Kinkead book describes institutional aspects of finance markets and the potential impact on segments of the hospital industry. There is, again, limited applicability to our investigation.

1.2 Theoretical Considerations and Predictions

Medicare reimburses hospitals for its "share" of allowable accounting capital costs. Allowable accounting capital costs include: (1) depreciation, (2) taxes on capital assets, (3) leases and rentals of capital assets,

(4) costs of betterments and improvements, (5) costs of minor equipment, (6) insurance on assets, (7) interest expense, (8) return on equity to proprietary hospitals (which is being phased-out), and (9) capital cost of related organizations.* It is widely believed that cost-based reimbursement of accounting capital costs over-stimulated hospital capital formation (cf., Cohodes and Kinkead, 1984). This notion will be considered along with other factors in order to determine whether PPS has changed the rate of capital formation.

Since capital is an input in the production of medical care and not an output, PPS is not expected to directly affect hospital investment. That is, PPS will affect the determinants of hospital investment and thus, indirectly, the levels of investment. To help assess the relative importance of the impact of PPS upon hospital investment, it is necessary to take the many factors which affect the scale of hospital investment into consideration. These factors can be grouped into six categories which should be considered: (1) the lead times associated with large-scale construction; (2) the uncertainty surrounding the ultimate inclusion of capital costs under PPS; (3) the impact of PPS DRGs upon hospital inpatient volume and profit; (4) the influence of cost-based reimbursement of capital costs on investment; (5) changes in the relative cost of capital, i.e., the price per unit of capital facing hospitals; and (6) miscellaneous factors both economy-wide and those specific to the hospital industry. Following the detailed discussion of these factors, a set of hypotheses are then presented about capital formation during the early years of PPS.

1.2.1 Lead Time in Construction

Unlike purchases of hospital supplies (e.g., bandages), purchase of new buildings and equipment (investment) usually requires considerable time. The amount of time involved depends on the type of investment. The two most

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*For a detailed description, see ProPAC, Technical Appendixes to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services, April 1, 1986, pp. 40-42.

important stages of the investment process are the planning and construction and/or delivery stages. Investment involving substantial new construction such as a new building or a new wing for an existing facility requires considerable time for both the planning and construction stages. Until contracts are signed the investment process can be easily interrupted and either be cancelled or postponed. Once contracts committing resources have been signed, it is difficult to halt the process, whether or not actual construction has commenced. The purchase of CT-scanners and other large-sized equipment often involves re-modeling existing facilities. It is quite plausible that planning and construction/delivery times for equipment purchases is much less than for major construction projects and hence it is likely that such purchases can be more easily cancelled or postponed. Similarly, purchase of monitoring and lab equipment probably involves less planning and delivery time than for large-sized equipment purchases. It is likely, then, that changes in hospital reimbursement, etc., will more quickly affect the purchase of equipment than major construction in the short run.

1.2.2 Uncertainty about the Integration of Capital Costs into PPS

One of the few areas of hospital costs still being reimbursed on a cost basis is capital. While it has been mandated that capital costs be integrated into PPS, there are several areas of uncertainty surrounding its inclusion. While inclusion dates have been proposed, there is still uncertainty as to the actual fiscal year in which this will happen. For instance, the final transition to 100 percent national rates for DRGs was postponed one year beyond that originally set. HCFA's suggested final rules for capital costs, effective in FY1987, have never been implemented. Congress has mandated that capital costs be treated on a cost basis until FY1992 (ProPAC, March 1988). Will inclusion of capital costs face another postponement? After an initial date has been finalized for treating capital costs on a prospective basis, how many years will the transition phase last? How will capital costs be factored into DRG payments? Or will there be some other prospective payment

mechanism? Will capital costs for movable equipment and buildings and fixtures be treated the same? Will depreciation, interest, and other types of capital expenses be treated the same? Will there be grandfathering provisions?

The above questions reflect only some of the areas of uncertainty facing hospitals as they contemplate investment decisions while awaiting the final inclusion of capital costs into PPS. What, if any, impact of this uncertainty has there been or will there be on investment decisions of hospitals? Will hospitals gamble and undertake costly capital projects, perhaps hoping for grandfathering provisions? Or are hospitals risk averse and will lower their rate of acquiring new physical capital? Will there be a change in the composition of investment to movable equipment which usually can be depreciated faster than buildings and fixtures?

1.2.3 Impact of PPS on Hospital Inpatient Volume and Profit

Of the various facets of PPS, the two that are most relevant are the DRG payments and the continued (temporary?) treatment of capital costs as a "passthrough." The separate impact of each of these is discussed in this and the following section and then the interaction between them is explored in Section 1.2.5.

The PPS impact on inpatient volume can be subdivided into its two constituent parts: length of stay and admissions. By paying a set amount per diagnosis, PPS imposes a revenue constraint per admission on hospitals. This creates an incentive for hospitals to reduce length of stay. Further, DRG-type payments provide an incentive to reduce ancillary tests provided during inpatient stays.

The impact of DRG payments on admissions is more complicated. The incentives PPS creates depends largely on the cost structure of the hospitals, whether services are produced at a cost above or below the DRG rates, and the goals of hospitals. Assume, initially, that all hospitals do not seek profits and that pre-PPS admission rates produce losses under DRG payment rates. The effect upon a particular hospital's admissions depends on a hospital's cost

schedule. If it can attain lower costs per case by changing admissions then it will attempt to do so (lowering admissions will likely be easier to achieve than increasing admissions). If changing admissions cannot prevent losses, then the hospital needs to change its behavior to become more efficient so as to get to a lower overall cost schedule. The net effect of DRG payments on admissions is thus uncertain. There is, however, an incentive to minimize hospital costs per admission. Dropping the assumption that all hospitals do not seek profits does not eliminate the uncertainty about the impact of DRG payments on admissions and might introduce uncertainty about the impact upon cost minimization in a dynamic situation. Some analysts, however, anticipated that paying hospitals on a per case basis instead of a cost basis would create incentive for hospitals to increase admissions (e.g., Guterman and Dobson, 1986).

The impact of PPS on inpatient volume, from a theoretical standpoint, is thus uncertain. If volume increases, then the demand for capital is likely to go up and if volume decreases, the demand for capital will probably go down. In addition to changes in volume, PPS might affect hospital "profits." If PPS causes profits to increase, then the cost of capital to the hospital declines which in turn increases the quantity of capital demanded by hospitals. In sum, theory does not provide an unambiguous prediction about the impact of PPS on inpatient volume and profit and hence, on the demand for capital.

1.2.4 Influence of Cost-Based Reimbursement on the Demand for Capital

Any hospital reimbursement mechanism will have an effect on the demand for inputs used in the production of medical services. The efficiency of producing inpatient services may be affected if the reimbursement mechanism: (1) distorts the mix of inputs and/or (2) encourages inappropriate levels of inputs. The second of these potential problems is discussed in this section.

As noted at the beginning of Section 1.2, it is widely believed that cost-based reimbursement encourages overuse of capital services. In particular, as noted by Wedig, Hassan, and Sloan (forthcoming), "prevailing

wisdom ... holds that cost-based reimbursement reduces the hospital's cost of capital and hence, always encourages capital acquisition." They then show, however, that cost-based reimbursement per se might not over-stimulate spending on capital goods. They show

> ...that if the effective return that the hospital's cost-based payers allow exceeds the hospital's true economic ... cost of capital, then marginal increases in cost-based share should stimulate capital acquisition and vice versa.

Divergence between accounting capital costs and the true economic cost of capital thus will likely affect hospital investment.

The conditions posited by Wedig, Hassan, and Sloan (forthcoming) on how cost-based reimbursement could affect the demand for capital apply to both proprietary hospitals and not-for-profit (voluntary) hospitals. The major difference between the two organizational forms is that the true economic cost may differ. In particular, the discount rate applied to future cash-flows may differ.

Divergence between the true economic cost of capital could arise from several sources. One important source is the potential difference between the allowed depreciation rate and the true economic depreciation rate. Other sources of divergence could arise from other not easily observable factors. This makes it easy for payers to incorrectly reimburse hospitals for capital. Thus, the major unanswered question is whether, in fact, the implicit or effective rate-of-return paid by cost-based payers has exceeded the economic cost of capital to the hospital.

1.2.5 Prices of other Inputs and Change in the Relative Cost of Capital

The cost of capital is not the only input "price" that can affect the demand for capital. In general, the prices of other inputs can also affect the demand for capital. How the price of another input can affect the demand for capital depends upon the technical relationship that input has with capital in the production of inpatient services.

If labor can be substituted for capital in some aspects of producing inpatient services, then the demand for capital partly depends on the price or wage rate of labor. Holding the "price" of capital and output constant, an increase in the price of labor causes the demand for capital to increase while a decrease in the price of labor causes the demand for capital to decrease. Simultaneous changes in hospital volume, however, could offset or reinforce changes in the relative price of capital. Since the true cost of capital does not usually stay constant, what is important then, is the price of capital relative to other input prices in the demand for capital.

Has PPS caused the price of capital relative to other inputs to change? In terms of the reimbursement parameters, it is not immediately apparent that this has happened. What is obvious is how PPS changed the nature of reimbursement. That is, under cost-based reimbursement, Medicare "guaranteed" its share of costs while leaving the rest to be covered by other payers. Under PPS, Medicare no longer guarantees that its payment will cover a hospital's cost. Thus, because hospitals are at more risk for labor inputs, hospitals might become more sensitive to market prices of inputs such as labor.

1.2.6 Miscellaneous Factors

In addition to PPS-induced changes on hospital demand for capital, there might be other factors specific to the health care industry which have affected the demand for capital by changing (say) the demand for hospital inpatient services. Economy-wide factors may also affect hospital demand for capital. For instance, long-term interest rates started a sustained decline after mid-1984.* This could lead to a decrease in the absolute cost of capital.

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*Prior to 1984, long-term interest rates peaked during 1981/2, declined in 1983, then rose until about mid-1984. Sources: Statistical Abstract of the United States: 1987 and Monetary Trends (August 1988).

1.2.7 Predictions

What is the net impact of PPS on investment? As should be clear, from a theoretical view, the net impact on investment is ambiguous. To make predictions about new investment, other factors need to be taken into consideration.

The following facts are considered in making predictions. First, the finding by Guterman and Dobson (1986) that Medicare admissions declined during the first year of PPS was confirmed in our data and that the decline continued through the reporting period beginning October 1, 1985 (the most recent data available for this study). Second, our data indicates that hospital profits increased during the first year of PPS. Third, long-term interest rates declined after mid-1984.

In addition to the above facts, the following assumptions are made. First, because of the difficulty in terminating investment decisions already made and construction in progress, gross investment would not be affected during the earliest year(s) of PPS. Second, because of uncertainty about the treatment of investment undertaken between the implementation of PPS and the inclusion of capital costs into the system, hospitals will try to change the mix of investments so as to increase the share in physical assets that can be quickly depreciated (i.e., equipment). Third, because of the continued treatment of capital costs as passthroughs and the decline of long-term interest rates, the relative cost (price) of capital declined after the implementation of PPS.

The above theory, facts, and assumptions are used to formulate the following hypotheses. First, capital assets will continue to increase during the first few years after the implementation of PPS. Second, movable equipment capital formation will react more quickly to environmental changes than buildings and fixtures capital formation. Specifically, the rate of investment in movable equipment will be less than the rate of investment in buildings and fixtures during the first year of PPS. After the first year of PPS, because of uncertainty about the integration of capital costs into PPS,

the rate of investment in building and fixtures should decline. On the other hand, after the first year of PPS, the rate of investment in movable equipment should be higher than the rate of investment in building and fixtures.

1.3 Data Base

The data used in this analysis came primarily from Medicare Cost Reports (MCRs) in the four Medicare payment periods TEFRA (FY1983) through PPS3 (FY1986). Supplemental data also came from corresponding American Hospital Association (AHA) annual surveys, from the Area Resource File (ARF), and data constructed from miscellaneous sources.

Analyzed hospitals included nonfederal, short-term, acute-care hospitals for which a MCR was received in all four periods. The following types of hospitals were not analyzed: (1) hospitals in PPS-waivered states (Maryland, Massachusetts, New Jersey, and New York), (2) hospitals exempt from the PPS (e.g., children's hospitals), and (3) hospitals which are not exempt from the PPS but for which a MCR was not available in all four analysis periods. A total of 3,795 hospitals were available for analysis. However, because of item nonresponse, especially during TEFRA, the number of observations used in calculating any one statistic is usually less than 3,795.

Since the number of hospitals available for analysis is less than the universe of eligible hospitals, a subanalysis was undertaken to determine if the analysis sample (cohort) was representative of all eligible hospitals. The cohort hospitals were contrasted to the universe of eligible hospitals by comparing the following characteristics: urban/rural status, bedsize, teaching status, ownership, and region. The following performance indicators were also compared: admissions, occupancy rates, length of stay, and cost per adjusted admission.

The analysis indicated that the cohort under-represents large urban hospitals, major teaching hospitals, and proprietary hospitals. Cohort hospitals, relative to the universe of hospitals, averaged about four percent fewer hospital admissions (the difference became larger over time), a 3 percent lower length-of-stay, two percent lower occupancy rates, and a

1.7 percent lower average cost per adjusted admission. Because of these differences, when possible, capital costs are also analyzed by controlling for hospital characteristics.

In addition to the usual problems of incorrectly entered data, etc., there was another serious problem with the MCR data. The MCR data, as originally received, had true zeros and missing data both coded as zeros; thus making it impossible to distinguish between the two. This presents a problem on how to treat zero values of particular variables. In many instances (for example, inpatient operating costs and inpatient discharges), it does not make sense for a hospital to have zero values and still be classified as a hospital. Thus, for the purposes of this study, zero values of all relevant variables were recoded to missing values, thus deleting the observations in calculating statistics.

Since the main focus of this analysis is on net fixed assets, its values were carefully examined before preparing the tables presented in the next chapter. First, net fixed assets were screened at both the top and the bottom. The reason for checking values that seemed to be too high has to do with how multi-facility hospitals completed the Medicare Cost Report. Multi-facility hospitals should have reported values of net fixed assets for only the reporting facility and not the entire system. Multi-site hospitals that appeared to report system assets had the fixed assets variable coded to missing. With regard to values of net fixed assets that seemed to be too low, it might be possible that some hospitals built over thirty years ago have the building completely depreciated. However, with rapidly changing technology, it is less likely that equipment would also be completely depreciated. Even the smallest and oldest hospitals buy new equipment. Therefore, values of net fixed assets less than $10,000 were recoded as missing values.

A second method of detecting dubious values of net fixed assets involved checking year-to-year changes. Hospitals that had annual increases greater than 100 percent or annual decreases greater than 50 percent received special attention. The net fixed assets, the number of hospital beds, and the ownership of these hospitals for all four periods were used to validate values of net fixed assets for a specific period. Re-valuation of assets presented a

special problem. This usually occurs when hospital ownership changes. Since the data did not allow the distinction between re-valuation of assets and changes to actual physical assets, values of net fixed assets were not set to missing in most instances (especially for increases). On the other hand, successive large changes in opposite directions often involved setting some or all of the values of net fixed assets to missing for a specific hospital.

Disaggregated net fixed asset data from the Medicare Cost Reports were not available. To assist in the evaluation of the composition of net investment in fixed assets, capital expenditures (gross investment) data from AHA annual surveys were also examined. One problem with the AHA data was that starting with the 1986 Annual Survey, the AHA no longer requested capital expenditures data. Thus, AHA capital expenditures data was only available through PPS2. (Net assets have not been available from the AHA since the mid-1970s.)

2.0 RESULTS

Statistics on net investment during the first few years of PPS are presented in this chapter. Net investment for a payment period is the difference between the previous period's ending balance of net fixed assets and the current period's ending balance of net fixed assets. (Net fixed assets is equal to the dollar valuation of gross assets less accumulated depreciation.) Net investment in physical assets is standardized for the size of the hospital in two ways. The first divides net investment by the previous period's ending balance of net fixed assets which yields the growth rate or percentage change in net fixed assets between two periods. The second definition is net investment in each period divided by the number of inpatient beds.

Standardization of net investment does not eliminate all problems in comparing growth rates of net fixed assets between hospitals. Consider the case where the (old) building and land have been completely depreciated or amortized. Suppose that the net valuation of equipment was equal to 100 thousand dollars and that a newly constructed building (with the same amount of square feet as the old building) was valued at 2.5 million dollars. This would yield a growth rate of 2,400 percent. In order to compare this growth rate to that of hospital which had been built, for instance, ten years ago, it would be helpful to know the age structure of the assets. Information about the age structure of assets would also help control for the fact that assets are valued in historical dollars instead of current market values. Information about the age structure of assets, however, is not available. For further discussion of these and other problems see the appendix.

Since disaggregated net fixed asset data from Medicare Cost Reports were not available, capital expenditure data from American Hospital Association (AHA) annual surveys was used to study the composition of net investment. Because asset data are not available from the AHA and the AHA capital expenditure data represent gross investment, gross investment per hospital and gross investment per bed per hospital are examined.

Both means and medians are used to describe hospital investment activity because the distributions of net fixed assets and growth rates of assets are highly skewed. Means are used to describe the aggregate investment behavior of hospitals. Medians are used to describe the investment activity of the "typical" hospital. The rationale for this usage is discussed in the appendix.

The first section of this chapter describes the distributions of net fixed assets per hospital and the distributions of net investment per hospital using MCR data. The second section presents net investment as stratified by hospital characteristics such as size and ownership. The third section examines the composition of gross investment using AHA data. The results are summarized and discussed in the fourth section.

2.1 Growth and Distribution of Net Fixed Assets per Hospital

The MCR data indicate that the nation's stock of hospital net fixed assets increased during each of the first three payment periods (years) of the federal prospective payment system. As will be discussed in more detail, the experiences of individual hospitals varied considerably. In any given PPS period, almost half of the hospitals in non-waivered states had less gross investment than depreciation and other asset disposal of existing assets.

Net fixed assets of hospitals increased each year during the first three periods of PPS (Table 2-1). Mean values of net fixed assets per hospital rose from ten million dollars to 13.1 million dollars between TEFRA and PPS-3 (asset values were not adjusted for construction cost inflation). These means imply* that the nation's stock of hospital net fixed assets grew 13.5 percent ($11,319,000/$9,972,000) during the first year of PPS, 7.4 percent during PPS-2, and 8.1 percent during PPS-3. Since these (weighted) growth rates exceeded the general rate of inflation, it is likely that the value of real net fixed assets increased.** Means of net fixed assets per bed grew from 57

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*Sample does not include hospitals which closed or opened between TEFRA and PPS-3.

**The relationship between nominal growth rates, the rate of inflation, and real growth rates is complex. See the appendix for an illustration.

TABLE 2-1

DISTRIBUTION OF NET FIXED ASSETS PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

QUANTILES	TEFRA	PPS 1	PPS 2	PPS 3
	NET FIXED ASSETS LEVELS (THOUSANDS OF DOLLARS)			
99	66,816	78,175	81,780	92,029
95	39,090	42,658	45,979	48,985
90	27,325	30,663	32,688	35,315
75	12,764	14,719	15,545	17,059
50 (Median)	4,008	4,694	4,981	5,356
25	1,311	1,495	1,567	1,650
10	558	620	674	702
5	353	380	412	427
1	105	140	157	154
Mean (unweighted)	9,972	11,319	12,154	13,139
Skewness	3.10	3.80	4.44	4.58
Number of Observations	3,158	3,631	3,641	3,631
	NET FIXED ASSETS PER BED			
99	206,784	236,823	250,889	279,280
95	133,578	149,962	161,923	175,989
90	106,751	125,662	134,501	147,945
75	76,778	87,074	95,242	103,057
50 (Median)	46,359	53,902	59,204	63,892
25	25,882	29,123	31,807	34,210
10	14,442	16,555	18,393	19,438
5	10,458	11,246	12,290	13,134
1	3,191	4,433	5,184	4,942
Mean (unweighted)	56,930	64,960	70,402	76,181
Skewness	4.24	3.41	2.94	2.25
Number of Observations	3,155	3,608	3,625	3,620

Notes: *Only for those hospitals which had MCRs available in all four periods. Dollar values have not been adjusted for inflation.

Source: Medicare Cost Reports (MCRs).
PC INVEST12 12/6/88.

thousand dollars per bed to 76 thousand dollars per bed between TEFRA and PPS-3 (Table 2-1, bottom). The growth rates of assets per bed based on these means were 14.1 percent during PPS-1, 8.4 percent during PPS-2, and 8.2 percent during PPS-3. The decline in the number of acute care hospital beds since 1984 (Hendricks, et al., 1988) is the most likely reason that the growth rate of assets per bed was slightly higher than the overall stock of net fixed assets. This indicates capital deepening; that is, there is more equipment, etc., per hospital bed. (The channels by which capital deepening takes place is explored later.)

The distribution of net fixed assets per hospital during PPS-3, as in the previous periods, was highly skewed. Fifty percent of the hospitals had less than 5.4 million dollars of net fixed assets. On the other hand, a small number of hospitals were very large: the value of net fixed assets leapt from 49 million dollars at the 95th percentile to 92 million dollars at the 99th percentile. The skewness measure increased from 3.1 to 4.58 between TEFRA and PPS-3 which indicates the largest hospitals grew more than smaller hospitals. Hospitals at the bottom one percent of the net fixed assets distribution probably were old hospitals which had completely depreciated the value of the building. Net fixed assets per bed were also highly skewed, but unlike assets per hospital, became less skewed between TEFRA and PPS-3. One possibility for this opposite movement is that smaller hospitals had, percentage-wise, more downsizing of bed capacity than larger hospitals.

Investment in structures is typically an infrequent event and, relative to equipment, is characterized by very large expenditures. Thus, it would be expected, for any given year that the distribution of the growth rates of hospital assets would be highly skewed. The distributions of growth rates of net fixed assets (Table 2-2) support this expectation. Growth rate distributions were, as well, more highly skewed than asset distributions.

The distributions of growth rates of net fixed assets reveal that there was considerable diversity of investment experience among individual hospitals. The unweighted mean growth rates in Table 2-2 were much higher than the weighted growth rates derived from Table 2-1's asset levels.

TABLE 2-2

DISTRIBUTION OF PERCENTAGE CHANGES OF NET FIXED ASSETS PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERCENTAGE CHANGE BETWEEN			
QUANTILES	TEFRA and PPS 1	PPS 1 and PPS 2	PPS 2 and PPS 3	Annual Percentage Change Between TEFRA and PPS 3
			PER HOSPITAL	
99	322.28	290.58	153.40	253.12
95	62.59	60.26	47.24	73.07
90	32.06	29.43	26.94	36.11
75	9.21	9.33	9.89	11.77
50 (Median)	0.28	0.49	0.70	2.19
25	-3.99	-3.91	-3.75	-2.23
10	-7.13	-7.05	-6.86	-4.87
5	-10.99	-9.34	-9.16	-6.54
1	-33.30	-25.35	-21.32	-12.33
Mean (unweighted)	18.90	16.85	10.12	16.89
Skewness	38.53	21.25	21.75	18.70
Number of Observations	3,127	3,599	3,600	3,121
			PER HOSPITAL BED	
99	333.20	266.40	171.23	263.83
95	79.78	68.28	58.79	82.98
90	46.75	37.19	35.58	44.24
75	16.96	13.59	14.15	16.24
50 (Median)	2.45	1.58	1.75	4.94
25	-3.69	-4.07	-3.79	-1.17
10	-7.60	-8.28	-7.83	-4.57
5	-12.52	-13.14	-12.33	-6.48
1	-32.60	-32.14	-27.84	-12.35
Mean (unweighted)	21.92	16.93	12.70	19.86
Skewness	24.21	22.43	24.93	12.45
Number of Observations	3,102	3,563	3,573	3,111

Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Medicare Cost Reports (MCRs).
PC INVEST12 12/6/88.

Table 2-2's mean growth rates were also much higher than the median growth rates. Indeed, more than 75 percent of the hospitals in any given period had growth rates less than mean growth rates.

Median growth rates ranged from 0.28 percent to 0.70 percent. This indicates, in any given year, that nearly half of the hospitals had depreciation (and other asset disposal) exceeding gross investment. In each period, however, almost 25 percent of the hospitals had growth rates exceeding ten percent. Growth rates that exceeded 100 percent usually represented small hospitals. Likewise, hospitals in the bottom one percent usually represented small hospitals. For instance, a hospital may have a completely depreciated building and only buys major new equipment every several years. If it bought a major piece of equipment with a life of three years, then the hospital's annual "growth" rate, after the period in which it was purchased, would be about -33 percent as the equipment was depreciated.

The growth rates per hospital bed (Table 2-2, bottom) exhibited the same patterns as growth rates per hospital. If the number of inpatient beds per hospital had not changed, then values in both sets of distributions would have been the same. Since the cohort hospitals appear to be downsizing as bed size fell from 150 to 137 inpatient beds, the two distributions are somewhat different.

In addition to the single period distributions, the mean growth rate over the four periods is shown in column four of Table 2-2. Since more years of activity were included in the calculations for this column, more hospitals had large expenditures and thus the distributions of mean growth rates were less skewed than the single period distributions.

The fourth column of Table 2-2 was derived by calculating, for each hospital, the mean annual growth rate. Casual inspection reveals that mean and median values of column four are not simple averages of the three individual year-to-year growth rates. Negative growth rates are the reason why column four's values are not simple means of the previous growth rates. Consider hospital C in Exhibit 2-1 which had growth rates of 5 percent, 0 percent and -5 percent (middle panel). The mean value was not calculated by taking the mean of these three values. Instead, it was based on the asset

EXHIBIT 2-1

HYPOTHETICAL ASSETS, GROWTH RATES, MEANS & MEDIANS OF DISTRIBUTIONS

ASSETS

HOSPITAL	TEFRA	PPS 1	PPS 2	PPS 3
A	$10,000	$10,000	$11,000	$11,880
B	14,000	13,300	14,630	16,093
C	10,000	9,500	9,500	9,975
D	8,000	8,000	7,600	7,220
E	10,000	18,000	17,100	16,245

GROWTH RATES

	TEFRA-PPS1	PPS1-PPS2	PPS2-PPS3	MEAN ANNUAL TEFRA-PPS3
A	0.0%	10.0%	8.0%	6.3%
B	-5.0%	10.0%	10.0%	5.0%
C	-5.0%	0.0%	5.0%	-0.1%
D	0.0%	-5.0%	-5.0%	-3.3%
E	80.0%	-5.0%	-5.0%	20.8%
Mean:	14.0%	2.0%	2.6%	5.7%
Median:	0.0%	0.0%	5.0%	5.0%

RANKINGS OF GROWTH RATES*

	TEFRA-PPS1	PPS1-PPS2	PPS2-PPS3	MEAN ANNUAL TEFRA-PPS3
High	80% (E)	10% (A)	10% (B)	20.8% (E)
	0% (A)	10% (B)	8% (A)	6.3% (A)
Median	0% (D)	0% (C)	5% (C)	5.0% (B)
	-5% (B)	-5% (D)	-5% (D)	-0.1% (C)
Low	-5% (C)	-5% (E)	-5% (E)	-3.3% (D)

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*Hospital id in parentheses.

values of in the top panel of Exhibit 2-1. As can be seen, for hospital C, the ending value of assets was less than the beginning value, thus yielding a negative overall mean. Medians are not the result of arithmetic calculations, instead, they are the result of an ordering process. Further, the median hospital can change from year to year. Thus there is no particular reason why column four's median growth rate should be the mean of the previous year's medians. The third panel of Exhibit 2-1 ranks the growth rates of the five hypothetical hospitals.

The foregoing discussion sheds light on why Table 2-2's column four values are not simply derived from the previous three columns. Put simply, because hospitals did not maintain their relative ranking each period, the values in column four do not have a simple relationship with the single period distributions. Because the "four-period" median hospital had sufficient investment during at least one period between TEFRA and PPS-3, its mean growth rate was positive instead of negative (see Exhibit 2-2 for an example). This result was fortuitous, it depended very much on the actual experience of hospitals. If there had been an investment slump, the typical (median) hospital may have had a mean negative growth rate between TEFRA and PPS-3.

Net investment per hospital and per hospital bed are shown in Table 2-3. Mean net investment per hospital was 790 thousand dollars during PPS-1, 926 thousand dollars during PPS-2, and 865 thousand dollars during PPS-3. In each of the periods, more than 75 percent of the hospitals had net investment less than the mean. Median values were considerably less than mean values. During PPS-1 median net investment was only four thousand dollars, during PPS-2 it was 12 thousand dollards, and 18 thousand dollars during PPS-3. On the other hand, median net investment over the entire four periods was 156 thousand dollars. Net investment per bed values (Table 2-3, bottom) show the same patterns as net investment per hospital. Median net investment per hospital bed was $75 during PPS-1, $213 during PPS-2, and $312 during PPS-3. Some of the increase in net investment per hospital bed can be attributed to the effect of downsizing the number of beds.

EXHIBIT 2-2

HYPOTHETICAL SINGLE AND MULTI-PERIOD MEDIANS

ASSETS

HOSPITAL	TEFRA	PPS 1	PPS 2	PPS 3
A	$10,000	$10,000	$11,000	$11,880
B	14,000	13,300	14,630	13,752
C	10,000	9,500	9,025	10,830
D	8,000	7,600	7,220	6,859
E	10,000	18,000	17,100	16,245

	TEFRA-PPS1	PPS1-PPS2	PPS2-PPS3	MEAN ANNUAL TEFRA-PPS3
	GROWTH RATES			
A	0.0%	10.0%	8.0%	6.3%
B	-5.0%	10.0%	-6.0%	-0.6%
C	-5.0%	-5.0%	20.0%	2.8%
D	-5.0%	-5.0%	-5.0%	-4.8%
E	80.0%	-5.0%	-5.0%	20.8%
Mean:	13.0%	1.0%	2.4%	4.9%
Median:	-5.0%	-5.0%	-5.0%	2.8%

RANKINGS OF GROWTH RATES*

	TEFRA-PPS1	PPS1-PPS2	PPS2-PPS3	MEAN ANNUAL TEFRA-PPS3
High	80% (E)	10% (A)	8% (B)	20.8% (E)
	0% (A)	10% (B)	2% (A)	6.3% (A)
Median	-5% (D)	-5% (C)	-5% (C)	2.8% (B)
	-5% (B)	-5% (D)	-5% (D)	-0.6% (C)
Low	-5% (C)	-5% (E)	-6% (E)	-4.8% (D)

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*Hospital id in parentheses.

TABLE 2-3

DISTRIBUTION OF NET INVESTMENT PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERIOD OF INVESTMENT			
Quantiles	PPS 1	PPS 2	PPS 3	Change Between TEFRA and PPS 3
	NET INVESTMENT (THOUSANDS OF DOLLARS)			
99	$15,338	$15,935	$15,434	$ 34,624
95	5,417	5,832	5,873	14,418
90	2,587	2,813	2,849	7,488
75	417	539	568	1,882
50 (Median)	4	12	18	156
25	-116	-116	-114	-156
10	-450	-451	-473	-716
5	-950	-936	-889	-1,509
1	-4,226	-2,693	-3,023	-4,993
Mean (unweighted)	790	926	865	2,417
Skewness	8.02	10.37	5.04	9.13
Number of Observations	3,127	3,599	3,600	3,121
	NET INVESTMENT PER BED			
99	$83,074	$77,186	$73,879	$146,410
95	32,445	30,377	31,234	76,998
90	15,710	16,558	17,505	47,017
75	3,785	4,788	5,255	17,008
50 (Median)	75	213	312	2,671
25	-1,717	-1,777	-1,793	-2,735
10	-3,856	-4,051	-4,236	-8,538
5	-6,306	-6,048	-6,636	-13,183
1	-22,534	-15,461	-16,829	-32,205
Mean (unweighted)	4,294	4,622	4,595	12,517
Skewness	4.78	5.25	5.53	-1.63
Number of Observations	3,105	3,585	3,589	3,114

Notes: *Only for those hospitals which had MCRs available in all four periods. Dollar values have not been adjusted for inflation.

Source: Medicare Cost Reports (MCRs).
PC INVEST03 12/1/88
PC INVEST14 12/9/88

2.2 Growth Rates by Hospital Characteristic

In this section, median growth rates of net assets are presented by hospital characteristic. Medians instead of means are used because of the distributions for each year were so positively skewed. The medians are presented for each of the three period changes and also for the three period average.

As seen in Section 2.1, for all hospitals, the median growth rate in net assets was slightly greater than zero percent each period and increased from period to period. In each of the three individual periods, the typical urban hospital had a growth rate of net assets ranging from two to three percent while the typical rural hospital had declines of about one percent in net assets (Table 2-4). In general, larger hospitals had higher growth rates of net assets. Only the smallest rural hospitals had negative growth rates in the individual periods although the three period average median growth rates were slightly above zero percent. Among rural hospitals, those that have the "Rural Referral Center" (RRC) designation had the highest growth rates of net assets. Those that had "Sole Community Hospital" (SCH) status had higher growth rates in conjunction with RRC status than without RRC status. Hospitals which only had SCH status, had two out of three times, higher individual period growth rates than rural hospitals without any special status. However, the three period average median growth rate of net assets of hospitals with no special status was higher than those hospitals which only had SCH status.

A special variable was constructed to measure hypothetical gains in profits as a result of the implementation of PPS. Hospitals with the lowest expected gains (Q1) had higher growth rates of net fixed assets than did hospitals that were expected to have the largest expected gains in profits. This would seem to indicate that potential "losers" under PPS reacted by investing more in capital assets. (A table not included in this report suggests that potential "losers" also increased assets per bed.)

TABLE 2-4

MEDIAN PERCENTAGE CHANGE IN NET FIXED ASSETS PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERCENTAGE DIFFERENCE BETWEEN			
Characteristic	TEFRA and PPS 1	PPS 1 and PPS 2	PPS 2 and PPS 3	Annual Percentage Change Between TEFRA and PPS 3
All Hospitals	0.28%	0.49%	0.70%	2.19%
Urban Hospitals	2.01	2.50	2.58	4.36
0 - 99 Beds	0.49	1.67	1.39	3.85
100 - 199 Beds	3.12	2.69	2.03	4.69
200 - 299 Beds	0.95	1.23	1.24	2.59
300 - 404 Beds	1.47	3.20	4.22	3.75
405 - 504 Beds	5.13	4.61	5.40	6.12
505 + Beds	6.07	6.89	7.00	9.90
Rural Hospitals	-1.09	-1.22	-0.59	0.73
0 - 49 Beds	-1.84	-2.28	-1.59	0.40
50 - 99 Beds	-1.17	-1.25	-0.87	0.15
100 - 169 Beds	0.18	0.76	0.98	2.65
170 + Beds	2.09	1.21	1.58	4.12
No Special Status	-1.21	-1.35	-0.92	0.66
Sole Community Hsp only	-1.09	-2.05	-0.49	0.12
Rural Referral Ctr only	0.94	1.75	2.86	4.18
Both SCH & RRC	2.59	1.14	-0.42	1.44
Hypothetical PPS Profitability Gain (LR) Quartiles				
Q1: -28.3% to -1.4%	0.04	1.20	0.63	2.50
Q2: -1.4% to 3.1%	1.19	0.44	1.38	2.68
Q3: 3.1% to 9.3%	0.17	0.31	1.20	1.75
Q4: 9.3% to 98.5%	-0.38	0.10	-0.22	1.88
Occupancy Rate (PPS 1) Quartiles				
Q1: 3.49% to 36.16%	-2.45	-1.88	-1.54	0.19
Q2: 36.16% to 49.52%	-0.05	-0.63	-0.29	1.37
Q3: 49.52% to 63.28%	0.69	1.35	1.50	2.91
Q4: 63.28% to 99.96%	3.31	2.77	3.26	4.47

TABLE 2-4 (continued)

MEDIAN PERCENTAGE CHANGE IN NET FIXED ASSETS PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERCENTAGE DIFFERENCE BETWEEN			
Characteristic	TEFRA and PPS 1	PPS 1 and PPS 2	PPS 2 and PPS 3	Annual Percentage Change Between TEFRA and PPS 3
Ownership				
State & Local Government	-1.11%	-0.53%	-0.54%	0.90%
Voluntary	0.58	0.67	1.18	2.01
Proprietary	1.63	2.87	1.23	7.00
Teaching Status				
Non-teaching	-0.07	0.23	0.31	1.90
Other Teaching	2.35	2.10	2.93	3.81
Major Teaching	0.85	3.29	4.76	5.38
Disproportionate Share Status				
Not Qualified	0.03	0.40	0.45	1.99
Large Urban	1.88	1.95	2.93	3.89
Small Urban	3.81	-1.65	-0.09	7.85
Rural	-1.36	-2.31	-0.91	0.81
Census Division				
New England	2.96	1.50	2.35	3.91
Mid Atlantic	0.86	0.77	1.53	1.21
South Atlantic	2.51	2.26	2.83	5.19
East North Central	-0.26	0.15	0.12	1.20
East South Central	-0.13	0.79	2.26	3.81
West North Central	-1.98	-1.41	-0.96	-0.37
West South Central	0.44	0.21	-0.13	2.75
Mountain	-1.44	-1.23	-0.13	0.77
Pacific	3.95	4.23	3.56	6.54

Notes: *Only for those hospitals which had MCRs available in all four periods.

Source: Unweighted values from Medicare Cost Reports (MCRs).
PC INVEST13 12/6/88.
PC INVEST09 11/22/88.

Hospitals with the highest occupancy rates during PPS-1 (Q4) had significantly higher growth rates of net assets than hospitals in the lowest quartiles. This result need not be in conflict with the result reported in the previous paragraph if occupancy rates and expected profitability gains are either not related or have an inverse relationship.

Proprietary hospitals by far had the highest growth rates. Public hospitals, however, did have a modest one percent average median growth rate of net assets between TEFRA and PPS-3.

Teaching hospitals had much higher growth rates of net assets than did non-teaching hospitals. Small urban hospitals with disproportionate shares of poor patients had higher asset growth than hospitals without significant numbers of poor patients. Rural hospitals disproportionate shares of poor patients had the lowest growth rates of net assets.

The fasting growing hospitals in terms of assets were located in the Pacific and South Atlantic Census divisions. Hospitals in the Mountain and West North Central Census divisions had negative growth rates in each of the three payment periods. West North Central hospitals also had a negative average median growth rate over the three payment periods.

Median net investment per bed per hospital (Table 2-5) exhibited most of the same patterns just described. The major differences were for disproportionate share status and census division. Different bases of net fixed assets accounts for the differences between Tables 2-4 and 2-5. This is most easily seen in the census division figures. The South Atlantic Census division had the second highest growth rate but (only) had the third highest amount of net investment per bed per hospital whereas the New England Census division had the third highest growth rate but the second highest amount of net investment per bed per hospital. It is well known that construction costs in New England are much higher than in the South.

TABLE 2-5

MEDIAN NET INVESTMENT PER BED PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERIOD OF NET INVESTMENT			Change Between TEFRA and PPS 3
Characteristic	PPS 1	PPS 2	PPS 3	
All Hospitals	$75	$213	$312	$2,671
Urban Hospitals	1,226	1,624	2,041	8,272
0 - 99 Beds	172	828	661	3,916
100 - 199 Beds	1,584	1,601	1,720	9,304
200 - 299 Beds	753	1,233	1,264	7,234
300 - 404 Beds	1,315	3,063	3,927	7,976
405 - 504 Beds	3,647	3,624	5,513	14,910
505 + Beds	4,931	5,998	6,178	23,554
Rural Hospitals	-312	-317	-223	711
0 - 49 Beds	-396	-557	-410	39
50 - 99 Beds	-358	-389	-290	185
100 - 169 Beds	25	339	474	3,956
170 + Beds	1,138	717	1,190	7,383
No Special Status	-356	-350	-305	580
Sole Community Hsp only	-379	-524	-170	120
Rural Referral Ctr only	498	960	2,051	7,610
Both SCH & RRC	939	726	-393	2,894
Hypothetical PPS Profitability Gain (LR) Quartiles				
Q1: -28.3% to -1.4%	25	766	253	4,399
Q2: -1.4% to 3.1%	477	251	838	3,781
Q3: 3.1% to 9.3%	32	189	665	2,422
Q4: 9.3% to 98.5%	-128	33	-49	1,326
Occupancy Rate (PPS 1) Quartiles				
Q1: 3.49% to 36.16%	-542	-421	-393	220
Q2: 36.16% to 49.52%	-10	-183	-128	1,481
Q3: 49.52% to 63.28%	341	790	1,019	4,899
Q4: 63.28% to 99.96%	2,217	2,003	2,585	9,483

TABLE 2-5 (continued)

MEDIAN NET INVESTMENT PER BED PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

	PERIOD OF NET INVESTMENT			Change Between TEFRA and PPS 3
Characteristic	PPS 1	PPS 2	PPS 3	
Ownership				
State & Local Government	$-312	$-142	$-180	$900
Voluntary	268	320	705	2,790
Proprietary	754	1,548	649	9,525
Teaching Status				
Non-teaching	-37	63	130	2,161
Other Teaching	1,656	1,707	2,179	8,342
Major Teaching	1,414	2,857	3,239	9,076
Disproportionate Share Status				
Not Qualified	1	169	195	2,262
Large Urban	1,237	1,457	2,247	7,402
Small Urban	1,238	-408	-37	7,295
Rural	-396	-552	-272	631
Census Division				
New England	2,081	929	2,091	7,308
Mid Atlantic	694	596	893	1,794
South Atlantic	859	1,031	1,433	5,945
East North Central	-189	63	74	1,707
East South Central	-76	173	895	3,975
West North Central	-581	-419	-353	-358
West South Central	96	61	-105	2,863
Mountain	-399	-405	-121	1,116
Pacific	2,168	2,833	2,271	8,495

NOTES: *Only for those hospitals which had MCRs available in all four periods. Dollar values have not been adjusted for inflation.

Source: Unweighted values from Medicare Cost Reports (MCRs).
PC INVEST13 12/06/88
PC INVEST10 11/22/88

2.3 Gross Investment per Inpatient Bed

The data in Table 2-2 suggest that hospitals were shifting the balance of investment more towards equipment than in bed capacity. To help get a sense of whether this impression is correct, AHA data on gross investment was examined. The examination of the AHA data also allows study of the relative reaction speed of the building and equipment components of gross investment. Since the set of 2,239 hospitals with AHA data analyzed is a subset of the cohort of 3,795 hospitals forming the main data base for this report, the AHA data was not stratified by hospital characteristic as done in the preceding section.

Mean and median gross investment per hospital for the payment periods TEFRA through PPS-2 are presented in Table 2-6 (collection of AHA gross investment data was discontinued during PPS-3). In most instances, when the mean increased or decreased, the median changed in the same direction. Aggregate gross investment for the 2,239 hospitals hardly changed as it ranged from 4.4 to 4.5 billion dollars (including construction in progress) over the three periods. This implies, given inflation, that real investment fell over these three periods.

While the aggregate gross investment remained relatively unchanged over the three periods, there were considerable year-to-year changes in its composition. The changes in the composition of gross investment were caused by the large year-to-year changes in spending on equipment and construction in progress. Mean construction in progress increased from 687 thousand dollars during TEFRA to 832 thousand dollars during PPS-1 and then fell dramatically (-33 percent) to 554 thousand dollars during PPS-2. Changes in the median values of construction were in the same direction as the mean values; however, movements of the median values were more dramatic. These movements in construction in progress conform to the predictions in Chapter 1 which argued that large scale construction projects would have a lagged response to PPS.

Both fixed and movable equipment, whether measured by means or medians, also exhibited very large year-to-year changes. Total equipment expenditures fell 20.5 percent from a mean of 758 thousand dollars during TEFRA to 603

TABLE 2-6

GROSS CAPITAL EXPENDITURES PER SHORT-TERM ACUTE CARE HOSPITAL IN NON-WAIVERED STATES, BY PERIOD*

					CHANGE BETWEEN	
	TEFRA	PPS 1	PPS 2	Annual % Change TEFRA and PPS 2	TEFRA and PPS 1	PPS 1 and PPS 2
Land						
Mean	$42,625	$49,223	$43,228	0.7%	15.5%	-12.2%
Median	0	0	696			
Buildings & Improvements						
Mean	509,517	520,852	502,715	-0.7%	2.2%	-3.5%
Median	81,401	105,417	103,655	13.7%	29.5%	-1.7%
Fixed Equipment						
Mean	178,861	147,746	192,254	3.7%	-17.4%	30.1%
Median	27,192	0	39,504	22.6%		
Movable Equipment						
Mean	579,094	455,077	665,839	7.5%	-21.4%	46.3%
Median	203,292	72,696	283,704	19.8%	-64.2%	290.3%
Total Equipment						
Mean	757,955	602,823	858,093	6.6%	-20.5%	42.3%
Median	272,328	102,564	353,064	14.8%	-62.3%	244.2%
Construction in Progess						
Mean	687,222	832,236	553,898	-9.7%	21.1%	-33.4%
Median	43,428	106,200	35,688	-8.9%	144.5%	-66.4%
Grand Total Capital Expenditures						
Mean	1,998,665	2,005,338	1,959,172	-1.0%	0.3%	-2.3%
Median	569,520	641,208	646,284	6.7%	12.6%	0.8%
Aggregate (Billions $)	4.475	4.490	4.387			

Notes: *Only for those hospitals which had MCRs available in all four periods and had valid values in each capital expenditure category (2,239 observations per period). Dollar values not adjusted for inflation.

Source: AHA Annual Surveys
PC INVEST02 11/16/88

thousand dollars during PPS-1 and jumped by 42.3 percent to 858 thousand dollars during PPS-2. These movements also conform to the predictions made in Chapter 1 which argued that expenditures on equipment could be quickly cancelled or postponed according to economic conditions. For instance, many hospitals feared that the DRG payment basis would cause substantial operating losses. The sharp reduction in equipment expenditures could plausibly be linked to this fear. Then, as is well known, hospitals enjoyed one of their most profitable years during PPS-1. A dramatic increase in equipment expenditures then followed in PPS-2. Thus, these movements also support the notion that hospitals could quickly react to favorable economic conditions. Because of lack of more years of data, however, it cannot be determined whether these changes in the composition of gross investment were caused by PPS or represent other economic or even random factors.

Means of the categories of gross capital expenditures per inpatient bed (Table 2-7) generally support the notion that there was a shift to more equipment per bed since the percentage increases in gross investment per inpatient bed are higher than per hospital. Median values, however, do not always support that conclusion. To the extent that there is capital deepening, it is apparent that it is not only due to downsizing of beds but also due to increased investment in equipment and decreasd expenditures on new facilities. Again, because of the lack of more years of data, it cannot be determined whether the observed capital deepening is a temporary or permanent phenomena.

2.4 Discussion

The emphasis of this report has been on median net investment of the typical hospital. Median values indicate that the typical hospital had little if any growth of real net assets in a given year (Table 2-2) since the implementation of the federal prospective payment system. Mean growth rates and the levels of net fixed assets (Table 2-1), on the other hand, indicate

TABLE 2-7

GROSS CAPITAL EXPENDITURES PER BED PER SHORT-TERM ACUTE CARE HOSPITAL IN NONWAIVERED STATES, BY PERIOD*

					CHANGE BETWEEN	
	TEFRA	PPS 1	PPS 2	Annual % Change TEFRA and PPS 2	TEFRA and PPS 1	PPS 1 and PPS 2
Land						
Mean	$207	$283	$306	23.9%	36.7%	8.1%
Median	0	0	5			
Buildings & Improvements						
Mean	3,157	3,543	3,443	4.5%	12.2%	-2.8%
Median	1,105	1,404	1,694	26.7%	27.1%	20.7%
Fixed Equipment						
Mean	1,038	847	1,269	11.1%	-18.4%	49.8%
Median	437	0	664	26.0%	-100.0%	
Movable Equipment						
Mean	3,338	2,464	4,206	13.0%	-26.2%	70.7%
Median	2,579	1,204	3,356	15.1%	-53.3%	178.7%
Total Equipment						
Mean	4,376	3,311	5,474	12.5%	-24.3%	65.3%
Median	3,219	1,618	4,125	14.1%	-49.7%	154.9%
Construction in Progess						
Mean	3,836	4,851	2,751	-14.1%	26.5%	-43.3%
Median	472	976	642	18.0%	106.8%	-34.2%
Grand Total Capital Expenditures						
Mean	11,588	11,991	11,991	1.7%	3.5%	0.0%
Median	6,782	7,708	7,715	6.9%	13.7%	0.1%

Notes: *Only for those hospitals which had MCRs available in all four periods and had valid values in each capital expenditure category (2,220 observations per period). Dollar values not adjusted for inflation.

Source: AHA Annual Surveys
PC INVEST11 11/23/88

possible increases in the real net assets of hospitals during this period. These two findings are not necessarily contradictory given that large-scale construction is, for individual hospitals, very episodic. A few number of hospitals had extremely large expenditures which were sufficient to offset the negative net investment of almost half of the hospitals. While the AHA data suggest a decline in real net assets of hospitals, the results based on AHA data should be treated cautiously because of the limited sample size.

AHA data supports the notion that expenditures for large-scale construction projects had a lagged response to changes in Medicare's reimbursement mechanism. The AHA data also indicates that hospital expenditures on equipment is sensitive to current economic conditions. Further, the AHA data indicates that downsizing of beds was not the only channel by which capital deepening occurred; increased spending on equipment and decreased spending on construction in progress were also factors.

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REFERENCES

Anderson, Gerard and Paul B. Ginsburg, "Prospective Capital Payments to Hospitals." Health Affairs, 2:3 (Fall 1983), pp. 52-63.

Bice, Thomas W., "Health Services Planning and Regulation." Introduction to Health Services, 2nd Edition, Edited by Stephen J. Williams and Paul R. Torrens, New York: John Wiley & Sons, 1984, pp. 375-402.

Cohodes, Donald R., and Brian M. Kinkead, Hospital Capital Formation in the 1980s. Baltimore: The Johns Hopkins University Press, 1984.

Cromwell, Jerry, Gerard Wedig, and Frank A. Sloan, "Medicare Medicaid Payment Policies and Hospital Capital Formation," Final Report for Cooperative Agreement No. 18-C-98267/1-02 (from HCFA). Chestnut Hill, MA: Center for Health Economics Resesearch, December 23, 1985.

Federal Reserve Bank of St. Louis. Monetary Trends (August 1988).

Gaynor, Martin and Ashley Stone, "The Effect of Medicare's Prospective Payment System on Hospital Capital Investment," Year One Technical Report for Contract No. 500-85-0015 (from HCFA). Needham, MA: Health Economics Research, Inc., May 8, 1987.

Hendricks, Ann, et al., "Medicare's Prospective Payment System and Changes in the Status of Acute Care Hospitals," Draft Final Report for Contract No. 500-85-0015 (from HCFA). Needham, MA: Health Economics Research, Inc., September 30, 1988.

Hillman, Bruce J., et al., "Diffusion of Magnetic Resonance Imaging into Clinical Practice." Rand Report R-3392-HHS, Santa Monica, CA: September 1986.

Kelly, Joyce V., "Determinants of Capital Acquisition by Nonprofit Hospitals." Rockville, Maryland: National Center for Health Services Research, U.S. Department of Health and Human Services, July 1984.

Kinney, Eleanor D. and Bonnie Lefkowitz, "Capital Cost Reimbursement to Community Hospitals under Federal Health Insurance Programs." Journal of Health Politics, Policy and Law, 7:3 (Fall 1982), pp. 648-666.

Prospective Payment Assessment Commission, "Medicare Prospective Payment and the American Health Care System, Report to the Congress," June 1988.

Prospective Payment Assessment Commission, "Technical Appendixes to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services, April 1, 1986 and April 1, 1987.

Sloan, Frank A., Joseph Valvona, and Mahmud Hassan, "Cost of Capital to the Hospital Sector." Journal of Health Economics, 7:1 (March 1988), pp. 25-45.

U.S. Bureau of the Census, "Statistical Abstract of the United States: 1987 and 1988," 107th and 108th Editions, Washington, DC.

Valvona, Joseph and Frank A. Sloan, "Hospital Profitability and Capital Structure: A Comparative Analysis." Health Services Research, 23:3 (August 1988), pp. 343-357.

Wedig, Gerard, et al., "Capital Structure, Ownership, and Capital Payment Policy: The Case of Hospitals." Journal of Finance, 43:1 (March 1988), pp. 21-40.

Wedig, Gerard J., Mahmud Hassan, and Frank A. Sloan, "Hospital Investment Decisions and the Cost of Capital." Journal of Business (forthcoming).

APPENDIX

Interpretation of growth rates of net assets of individual enterprises, whether they be hospitals or firms in other industries, is fraught with many problems both for the analyst and the policy-maker. The main problem is caused by the dominant building component of assets. Construction of a new building or the addition of a wing are expensive and infrequent events and, as a consequence, investment can vary widely from period to period without any ill effects on the economic health of the hospital/firm.

Six of the many problems and pitfalls that can plague the analysis of hospital investment are discussed in this appendix: (1) problems in using means or medians to describe investment activity; (2) instead of using all hospitals, as discussed in Chapter 1, the analysis is restricted to a cohort (this problem may be unique to this study); (3) the age structure of assets can confound the analysis; (4) the use of historical cost of assets; (5) the composition of assets; and (6) the "quality" of the assets. Each of these is briefly discussed below. These problems are not restricted to the type of descriptive analysis undertaken in this study, they are also a problem for multivariate analysis. Without more information in the last four of these areas, both types of analysis need to be accompanied by appropriate caveats. This appendix does not address questions relating the growth rates of net assets to the alleged over-supply assets nor to the impact of rivalry between hospitals upon the acquisition of assets.

A.1 Means or Medians

Basic notions of statistics are reviewed in this section and then building on the review, a rationale is presented for why specific statistical measures are used to describe aspects of investment activity. The fact that hospitals do not all have the same investment (or whatever) activities (attributes) suggests that there is a distribution of experiences. Since it is usually difficult to convey in words aspects of a distribution,

statisticians have devised several summary measures by which to characterize the attributes of distributions. The most commonly used summary statistics are reviewed here.

The most well known summary statistics are those which indicate the location (or central tendency) of a distribution. The concept of location, in common language, is usually referred to as the "average." The arithmetic mean and the median are most commonly used averages with the mode less frequently used. The arithmetic mean is calculated:

$$\frac{X_1 + X_2 + \ldots. + X_n}{n}$$

where n is the number of observations of individual X_i values. The median is determined by ordering the individual X_i values from smallest to largest. The median is then the middle value of the ordered distribution, or equivalently, the value which divides the n values into two groups with the same number of observations in each group. The mode is the most frequently occurring value the X_i have. The following example shows values which the mean, median, and mode can take. Let the five observations of a distribution take the values: 1, 5, 10, 16, and 16. The mean is 9.6, the median is 10, and the mode is 16.

Which average to use depends on the distribution one is trying to describe. In the case of a bell-shaped symmetrical distributions such as a normal distribution, the mean, median, and mode all take on the same value. Figure A-1 shows a normal distribution and where the values of the mean, median, and mode are located. In an uniform or rectangular distribution (Figure A-2), the mean and median also have the same value but the mode really cannot be defined since all values have the same frequency.

The mean and median are usually not equal to each other in non-symmetrical distributions. A non-symmetrical distribution is often characterized by having observations concentrated on one end of its tail while the other tail is stretched out such as in Figure A-3. The notion of non-symmetry of a distribution is captured by the skewness measure. Skewness, in common language, is often denoted by whether the distribution is skewed to the right (positively skewed) or to the left (negatively skewed). Figure A-3

FIGURE A-1

NORMAL DISTRIBUTION

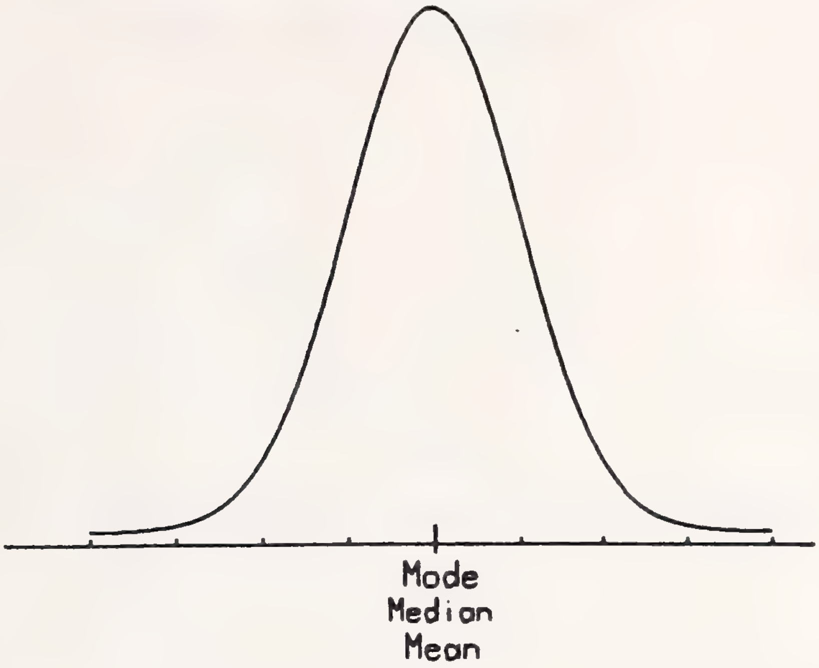


FIGURE A-2

UNIFORM (RECTANGULAR) DISTRIBUTION

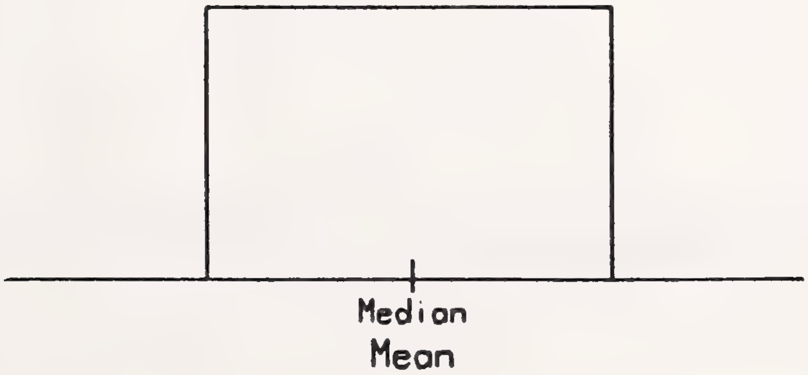


FIGURE A-3

DISTRIBUTION SKEWED TO RIGHT

(Positively Skewed)

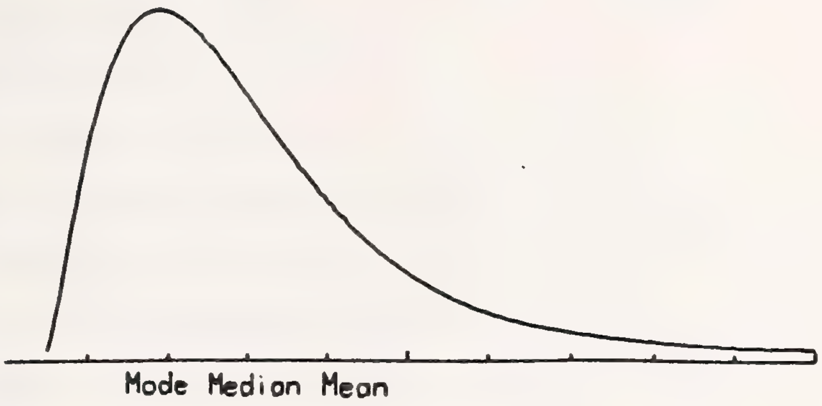
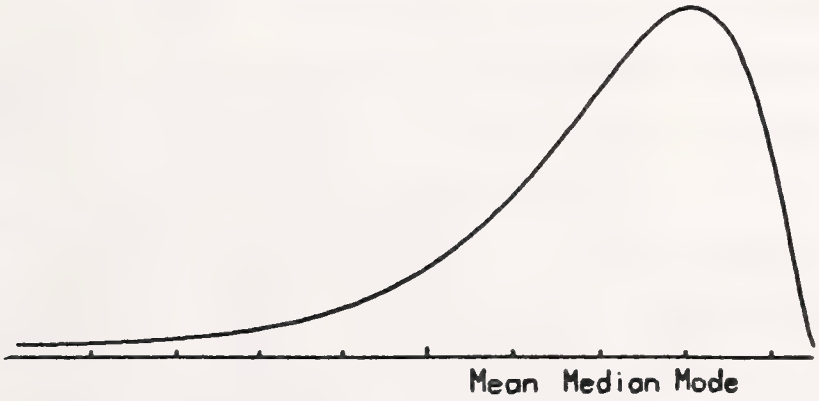


FIGURE A-4

DISTRIBUTION SKEWED TO LEFT

(Negatively Skewed)



is an example of a distribution which is skewed to the right (positively skewed) while Figure A-4 is an example of a distribution which is skewed to the left (negatively skewed). The relative locations of the mean, median, and mode are shown in both Figures A-3 and A-4. Extreme values affect the mean but not, for all practical purposes, the median or mode. Indeed, for skewed distributions, the mean is very sensitive to extreme values (and even more so when there are few observations).

When distributions are not symmetrical, a decision needs to be made on whether to use the mean or the median or both to characterize the distribution's location (the mode is ignored hereafter). To give more life to this discussion, another notion underlying the concept of average is introduced. Average is often used as to describe what happened to (is the characteristic of) the typical observational unit. In this light, the mean involves the idea of taking all of the individual values of the distribution and spreading them equally over each observation. Thus, in a sense, the mean is an egalitarian measure of average. The median is essentially a dividing line which separates a distribution into two groups with the same number of observations. The median thus indicates the value of the middle observations.

A further complication in deciding whether to use means or medians is the objective of the analysis. For instance, in predicting future characteristics of a distribution, the use of the mean or median depends on whether aggregate or typical behavior is to be predicted. Thus, whether to use the mean or median really depends on the type activity or attribute being analyzed and the objectives of the analysis.

The infrequent nature of large-scale construction projects implies that single period distributions of growth rates (or whatever investment measure used) are positively skewed. Thus means are larger than medians. As shown in Chapter 2, depending on the measure of investment employed, means can be ten to twenty times larger than medians. Hence, when describing the activity of a typical hospital, means can be very misleading.

There are circumstances in which means can be used if judiciously employed. For instance, means can be used to extrapolate aggregate figures. As an example, suppose an analyst has data on the current and previous year's

net fixed assets for a random sample of hospitals. From this sample, the analys can calculate growth rates of asset. Suppose, further, that the analyst has, from another source, an estimate of the previous year's national stock of hospital net fixed assets. The analyst can then use the mean growth rate of net fixed assets in conjunction with the previous year's estimate of the national stock to obtain a estimate of the current year's stock of hospital assets.

A.2 Cohort versus All Hospitals

This study restricted itself to analyzing only those hospitals which submitted MCRs in all four of the Medicare payment periods for which data was gathered. The primary purpose of this restriction was to avoid the problem of missing information from period to period. This restriction, however, created its own problems. In particular, hospitals that closed or opened during the analysis period were not included in the study. Thus, this type of dynamic activity was excluded from the analysis. The omission of this type of activity was not judged a serious problem because of the low numbers of hospitals that opened or closed and because of the short analysis period. As described in the previous section, means can be used to extrapolate national figures to account for non-cohort hospitals.

A.3 Age Structure of Assets

Differences in the age structure of assets can yield growth rates which differ between hospitals. The differing growth rates, however, might not signify any differences in the economic health of hospitals nor differences in the health status of the population served by the hospitals.

Consider two hospitals that were built four years apart, each costing ten million dollars with an expected life of forty years (straight-line annual depreciation of 250 thousand dollars). Suppose that there was no inflation of construction costs and that neither hospital acquires new assets until seven years after the first hospital was built. Six years after the first hospital

was built, the first hospital had net assets worth 8.5 million dollars while the second hospital had net assets worth 9.5 million dollars. At the end of the seventh year after the first hospital was built, both hospitals purchased the same major piece of equipment worth 300 thousand dollars which resulted in a net increase of assets of 50 thousand dollars ($300,000 - $250,000) for each hospital at the end of the seventh year. The growth rate (percentage increase in net assets) for the first hospital was 0.58 percent and for the second hospital it was 0.53 percent. Thus, because of the difference in age of the facilities, the growth rates for older hospitals is larger than new hospitals for the same dollar investment in new assets.

If the above hospitals had the same number of beds, then net investment per bed would be the same. If they did not have the same number of beds, however, investment per bed could be misleading. And if each hospital did not have a change in their number of beds, then the growth rate of assets per bed would reflect the overall growth rates above.

In conclusion, without knowledge of the age structure of assets, as well as other information about the economic situation of the hospitals being compared, inferences about differences in growth rates might be unsubstantiated.

A.4 Historical versus Market Values

On the Medicare Cost Report, valuation of physical assets and depreciation is based on historical costs. (Historical valuation of assets is also required by the Internal Revenue Service on tax returns of all for-profit companies.) This causes growth rates of net assets to be overstated during periods of inflation. Three situations are presented to help show how growth rates of net assets can be overstated.

In Table A-1, changes in net assets during the year following the construction of a hospital for ten million dollars are traced. First consider the case of no inflation (inflation factor equal to one); annual depreciation is 250 thousand dollars. During the year, the hospital "replaces the used up"

TABLE A-1

GROWTH RATE OF ASSETS, INFLATION, AND BOOK VALUATION OF ASSETS

Inflation Factor	Valuation of Assets		Depreciation	Gross Invest	Book Value of Ending Assets	GROWTH RATES OF NET	
	Market	Book				Nominal Assets	Real Assets
Book Value = Market Value							
1	$10,000,000	$10,000,000	$250,000	$250,000	$10,000,000	0.00%	0.00%
1.05	10,500,000	10,500,000	262,500	262,500	10,500,000	0.00	0.00
Book Value = Original (Historical) Value							
1.05	10,500,000	10,000,000	250,000	262,500	10,012,500	0.13	0.00

Notes:
1. Original (historical) purchase price was 10 million dollars.
2. Asset life assumed to be 40 years, straight-line depreciation.
3. Data reflect changes one year after purchase.
4. An inflation factor of 1 indicates no inflation. A factor of 1.05 indicates a 5% inflation rate.

capital by a gross investment of 250 thousand dollars leaving both the book and the real value of assets at ten million dollars. In this case, the growth rate of assets is correctly represented as zero percent.

In the second example, during a period of five percent inflation, it would cost $262,500 to replace the "used up" capital. The correct market valuation of the gross assets is now 10.5 million instead of ten million dollars. The second row of Table A-1 represents the case of the accounting books reflecting market instead of historical costs. Because gross assets were revalued upwards, so must be depreciation. Again, as in the first case, the correct growth rate of net assets is zero percent.

The third example combines the five percent rate of inflation with the practice of carrying historical costs on the books. In this case, because depreciation is based on historical costs, net investment and hence, growth rate of net assets is overstated. The growth rate of net nominal (historical) assets is 0.13 percent while the growth rate of net real assets remains, as it should, at zero percent. Thus the (common) practice of carrying historical costs of assets on the books can cause growth rates to be overstated such that what appears to be increases in net assets are really decreases in net real assets. Further, this example illustrates that the growth rate of real assets cannot be calculated simply by subtracting the rate of inflation from the rate of growth of nominal assets.

A.5 Composition of Assets

Growth rates of assets can differ because hospitals may have differing preferences about the types of assets they wish to acquire. Some hospitals may eschew high-priced, high technology equipment in favor of basic inpatient care. These hospitals would then have inpatient beds as the main component of assets. By comparison to hospitals which purchase relatively more equipment, hospitals which prefer beds would have lower growth rates for a given year (except for those years when the "low-tech" hospitals undertake large-scale rennovation or construction projects).

A.6 Quality of Assets

Closely related to the topic of the composition of assets is the quality of assets. Assets that embody higher degrees of quality may contribute to better patient outcomes. For instance, magnetic resonance imaging is superior to other diagnostic equipment (e.g., x-ray equipment) in the detection of some conditions (especially those involving soft tissues). The higher quality equipment is typically much more expensive than the lower quality equipment. Thus, hospitals which purchase the more expensive higher quality equipment are likely to have higher growth rates of assets. (Note that the example of quality differences used here differs from most discussions in which, say, two x-ray machines are compared to each other.)

The problem facing the analyst or policy-maker is that it is difficult to measure the quality of equipment or, for that matter, the quality of care (outcomes). Hence, when growth rates between hospitals reflect differences in the quality of equipment, it is difficult to make inferences about the economic health of hospitals.

Prospective Payment System Evaluation Studies--

The Fairness of the PPS Reimbursement Methodology

by
Frank D. Gianfrancesco

In FY 1984 the Medicare program implemented a new method of reimbursing hospitals for inpatient services, the Prospective Payment System (PPS). Under this system hospitals are paid a predetermined amount per Medicare discharge which varies according to certain patient and hospital characteristics. This paper investigate the presence of systematic biases in the PPS reimbursement methodology as revealed by its effects on Medicare operating ratios. The study covers the first three years of the PPS (approx. 1984-86) and is based on hospital data from the Medicare Cost reports and other related sources. Regression techniques were applied to these data to determine how Medicare operating ratios were affected by specific aspects of the reimbursement methodology. Several possible imbalances were detected. The potential under-compensation relating to these can be harmful to certain classes of hospitals and to the Medicare populations that they serve.

1. Introduction

The need to contain rapidly rising health care costs has long been a dominant feature of federal health care policy. From the time the government assumed the role of financing the health care of the elderly with the establishment of Medicare, the financial viability of this program has been threatened by a relentless escalation in health care costs. While the growth in Medicare expenditure over time is the expected consequence of an expanding elderly population and advances in medical technology, the increased federal resources devoted to this program have also been largely due to inefficiencies in the health care system. The prevalence of retrospective cost-based reimbursement for inpatient services has given hospitals little incentive to control their costs. In an effort to contain the growth in program outlays for these services, the federal government radically altered Medicare reimbursement with the implementation of the Prospective Payment System (PPS).

The key feature of the PPS is that the major portion of the reimbursement per Medicare case does not vary with the specific costs of that case. While the payments do vary to account for certain differences among patients and hospitals, they do so imperfectly. The PPS essentially reimburses on the basis of averages with hospitals gaining or losing depending on whether their specific costs per case are below or above average. This method of reimbursement is assumed to encourage efficiency by creating incentives for cost-conscious behavior. However, if there are imbalances in the methodology and if it fails to adequately accommodate legitimate cost differences among hospitals, then its effects could be counter-productive.

There has been much speculation regarding the impact of the PPS on hospitals. To date, a very limited number of published studies have attempted to quantify these effects. All of these have focused on the impact of the PPS on hospital behavior. (See, for example, Gutterman and Dobson, 1986; DesHarnais, 1987; Feder, Hadley and Zuckerman, 1987; and Long et al., 1987.) None, to our knowledge, have attempted to statistically assess the fairness of the PPS reimbursement methodology.[1] This latter issue is the subject of the present study. Imbalances in the reimbursement methodology were evaluated through an analysis of the Medicare operating ratios experienced by hospitals during the first three years of the PPS.[2] Before methods and results are discussed, a description of the PPS reimbursement methodology is presented.[3]

2. The PPS Reimbursement Methodology

The PPS is a profound modification of the way in which Medicare reimburses hospital inpatient costs. In contrast to earlier cost-based reimbursement, the principal form of payment is a predetermined amount per Medicare discharge which varies according to the Diagnostic Related Group (DRG)[4] into which the patient is classified and certain characteristics of the hospital. During the initial years of the PPS, the "DRG amount" per discharge has been based on a mix of hospital-specific, regional and national Medicare costs. Regional and national costs per case are separated into metropolitan and non-metropolitan and hospitals in each area are paid rates which reflect these differences.[5] A weighted average of the above costs per case is calculated for each hospital and serves as the base for the DRG amounts. Before the weighted average is computed, however, each component is subjected to a number of adjustments, those applying to the hospital specific component differing from those applying to the regional and national components.

The hospital-specific component, which is calculated for a base period, is divided by the hospital's DRG case mix index.[6] This removes the effects of its historical case mix on the hospital's costs per Medicare discharge. The amount is then reduced by a factor which reflects the estimated portion (system-wide) of DRG reimbursements that will be in the form of outlier payments.[7] The final adjustment to the hospital-specific component is an update for estimated inflation.

The regional and national costs per discharge applicable to each hospital depend on whether it is metropolitan or non-metropolitan. The regional component also depends on the Medicare Region (one of nine) in which the hospital is located.[8] These components, which are also calculated for a base period, are first multiplied by a wage index to reflect the hospital's relative labor costs. Wage indices vary by state and metropolitan area.[9] The next adjustments are an inflation update and an adjustment for outlier payments.[10] Other minor adjustments are also made which are ignored here.

All three components of the base are then each multiplied by a weight and added to yield a weighted average.[11] A unique weighted average is calculated for each hospital and serves as the base for determining its DRG amounts. This base is multiplied by a DRG weight to yield the specific DRG amount that a hospital receives for a given Medicare discharge. The weight applied depends on the DRG into which the discharge is classified. In addition to the DRG amount, the hospital may receive extra payment if it is a teaching hospital or if the Medicare discharge is a cost or length-of-stay stay outlier.[12,13]

The above payment does not cover capital costs as well as other items of lesser importance (e.g. direct medical education costs and kidney acquisition costs). These continue to be reimbursed on a cost basis and are termed passthroughs.

The preceding description of Medicare DRG-based reimbursement may be summarized with the following equation:

$$P_{ijn} = w_j \{ [(H_i / CMI_i)a + (R_i b + N_i c) \times WI_i] \times INFL \times OP \} + OUTP_{ijn} + IME_i + K_i + O_i \qquad (1)$$

where

i = the (i)th hospital.

j = the (j)th DRG.

n = the (n)th patient.

P_{ijn} = the total Medicare payment to the (i)th hospital for the (n)th patient in the (j)th DRG.

w_j = the weight for the (j)th DRG.

H_i = the hospital-specific component of the base for the (i)th hospital.

R_i = the regional component of the base applicable to the (i)th hospital.

N_i = the national component of the base applicable to the (i)th hospital

a = the weight applicable to H.

b = the weight applicable to R.

c = the weight applicable to N.

CMI_i = the DRG case mix index of the (i)th hospital.

WI_i = the wage index applicable to the (i)th hospital.

$INFL$ = the inflation update factor.

OP = the outlier payment adjustor.

IME_i = the add-on for indirect medical education costs applicable to the (i)th hospital.

$OUTP_{ijn}$ = the outlier payment to the (i)th hospital for the (n)th patient in the (j)th DRG.

K_i = the capital cost passthrough per discharge for the (i)th hospital.

O_i = other cost passthroughs per discharge for the (i)th hospital.

It should also be noted that two types of non-metropolitan hospitals have been designated for special payment under the PPS: sole community providers and rural referral centers. For sole community providers, the hospital-specific component of the base retains its initial weight and is not gradually eliminated with full implementation of the PPS.[14] Rural referral centers differ from other non-metropolitan hospitals in that their rate base is determined using the regional and national cost components that are applicable to metropolitan hospitals.

Each hospital's Medicare operating ratio is defined and calculated from the above as follows:

$$\frac{(\text{Medicare inpatient revenue - Medicare inpatient cost})}{(\text{Medicare inpatient revenue})}$$

where

$$\text{Medicare inpatient revenue} = \sum^{n} P_{ijn}$$

and

$$\text{Medicare inpatient cost} = \sum^{n} (H_i + ME_i + K_i + O_i)$$

3. Methods

Regression techniques were applied to Medicare data to explain the variation in Medicare operating ratios among hospitals subject to the PPS.[15,16] The objective was to determine if this variation is systematically related to features of the reimbursement methodology and if so, how were hospitals affected. The period of analysis is roughly 1984-86.

Hospitals were divided into three geographic groups for purposes of this study: rural, middle and urban. The rural and middle groups are a disaggregation of the non-metropolitan classification used by Medicare. Urban is equivalent to metropolitan. Rural group hospitals are those located in non-metropolitan counties that are more isolated. Middle group hospitals are those located in counties that are nearer to urban.[17] Hospital geographic location is used as a basis for disaggregation because it is one of the most important policy issues relating to PPS reimbursement.

Non-metropolitan hospitals are generally paid lower rates under the PPS than metropolitan hospitals. The principal reason for this is that their unit costs have historically been lower (even after adjusting for differences in labor costs). Also, it is our view that the payment of lower basic rates to non-metropolitan hospitals may be particularly harmful to those that are nearer to metropolitan, i.e. the middle group. For this reason, non-metropolitan hospitals have been disaggregated into rural and middle. Geographic disaggregation enables us to better assess the appropriateness of the different payment scales.

Medicare operating ratios for the first three years of the PPS are presented in Table 1.[18] PPS1-PPS3 roughly corresponds to the period 1984-86. Ratios are listed by hospital geographic location and bed size (a common categorization). Medicare operating ratios declined for nearly all hospital groups between PPS1 and PPS3. While this decline was not evenly distributed among the hospital categories, some inter-group differences remained fairly stable throughout the period. Non-metropolitan hospitals consistently had lower ratios than metropolitan hospitals and larger hospitals generally experienced higher ratios than smaller ones (with the differences being less pronounced among urban hospitals). However, there is no indication that hospitals in the middle group were particularly disadvantaged because of their proximity to urban. Medicare operating ratios for these were generally no lower than those for the rural group.

It is unclear, based on these comparisons, whether the lower Medicare operating ratios for non-metropolitan hospitals are attributable to the lower payment scales for these or to other aspects of the reimbursement methodology. Similarly, factors other than bed size may explain the lower ratios generally observed for smaller hospitals. While comparisons of group means are useful as a starting point, they are of limited use for isolating the specific sources of compensation imbalance. The regression analysis provides more detailed and reliable evidence.

Regression models were estimated to identify specific imperfections or omissions in the PPS methodology which may have caused hospitals to be compensated differently. If the methodology is fair, then there should be no relationship between its structure and Medicare operating ratios. This is especially true of hospital characteristics that were explicitly recognized as being legitimate bases for differentiating payments and, therefore, incorporated into the methodology. These include wage and case mix differences and geographic location. Statistically significant relationships between any of these and Medicare operating ratios would likely reflect imperfections in the PPS reimbursement methodology. An alternative explanation is that they may reflect differences in hospital efficiency which are correlated with case mix, wage levels and geographic location. However, one would need a strong theoretical basis for inferring such relationships and, to our knowledge, no such arguments have been made.[19]

Other aspects of the methodology, such as the treatment of capital as a cost passthrough, the payment for outliers and the add-on for indirect teaching costs were known to be imperfect. For example, because of differences in capital intensity, more equitable hospital reimbursement would likely result if these costs were included in the DRG amounts. Also, it was known that outlier payments might not provide adequate compensation for the incremental costs associated with these cases. And lastly, the teaching add-on was deliberately set so as to over-compensate. Statistically significant relationships were, therefore, anticipated between Medicare operating ratios and these components of the reimbursement methodology.

Some hospital characteristics that could reflect legitimate cost differences were ignored in developing the payment methodology. These include hospital size and occupancy levels. The presence of scale economies would seem to place smaller hospitals at a disadvantage while relatively high fixed costs would seem to disadvantage low occupancy hospitals. Though statistically significant relationships between these and Medicare operating ratios suggest a potential for under-compenation, modifications to the PPS methodology are not easily justified because allowances for size and occupancy could interfere with hospital incentives for efficiency.

Our approach to testing for compensation imbalances was to estimate the statistical relationships between the Medicare operating ratios experienced by hospitals during the first three years of the PPS and the several aspects of the payment methodology. Medicare operating ratios for each hospital were averaged over the three PPS years.[20] These averages were then regressed on variables reflecting aspects of the reimbursement methodology and other potential determinants of Medicare operating ratios. Where appropriate, these explanatory variables were also averaged over the three PPS years. Separate regressions were estimated for the rural, middle and urban groups. This disaggregation enabled a better assessment of how the different geographic classes of hospitals may have been differentially affected by specific aspects of the PPS methodology. The model applied to each of these groups was specified as follows:

$$MOR = a + [\ b_1 SOLE + b_2 REFER + b_3 CMI + b_4 WAGE + b_5 OUT + b_6 TCH$$

$$+ b_7 PASS + b_8 KPASS\ ] + b_9 BEDS + b_{10} OCCUP + b_{11} MDCR + \quad (2)$$

$$b_{12} ARCODE + b_{13} PROF + b_{14} VOL + e$$

where

MOR = each hospital's average Medicare operating ratio averaged over the three PPS years.

SOLE = a dummy variable taking the value of 1 if a hospital was designated as a sole community provider and 0 otherwise. (Applies to hospitals in the rural and middle groups only.)[21]

REFER = a dummy variable taking the value of 1 if a hospital was a rural referral center and 0 otherwise. (Applies to hospitals in the rural and middle groups only.)[22]

CMI = each hospital's Medicare case mix index (based on its DRG mix). This is averaged over two years only, 1984 and 1985.[23]

WAGE = each hospital's Medicare wage index which varies by state and metropolitan area. This is also averaged over two years only, 1984 and 1985.[24,25]

OUT = each hospital's ratio of DRG outlier payments to DRG non-outlier payments averaged over the three PPS years. (DRG payments are all Medicare payments excluding passthroughs.)

TCH = each hospital's add-on for indirect teaching costs averaged over the three PPS years. (As noted, this applies only to the hospitals that are classified under the PPS as having some teaching function.)

PASS = each hospital's ratio of Medicare total passthrough payments to total Medicare inpatient revenue, averaged over the three PPS years.

KPASS = each hospital's ratio of Medicare capital passthrough payments to total Medicare inpatient revenue, averaged over the three PPS years.

The above variables (which are bracketed in equation 2) reflect specific aspects of the PPS reimbursement formula. Statistically significant relationships between any of these and Medicare operating ratios may indicate flaws in the formula. The following variables represent hospital characteristics that were not incorporated into the PPS formula, but are likely to explain some of the variation in Medicare costs and operating ratios. To the extent that these represent legitimate cost differences among hospitals, they should be incorporated into the formula. To the extent that they reflect differences in hospital efficiency, they should not be.[26]

BEDS = each hospital's total bed complement, averaged over the three PPS years. Medicare unit costs and, therefore, operating ratios would be affected by hospital size if there are economies of scale in the provision inpatient services.

OCCUP = each hospital's occupancy rate, averaged over the three PPS years. Low occupancy hospitals are likely to have considerably higher unit costs. Occupancy should, therefore, affect Medicare operating ratios.

MDCR = each hospital's ratio of Medicare discharges to total discharges, averaged over the three PPS years. To the extent that there are economies or efficiency gains from treating higher proportions of Medicare cases, this could affect operating ratios.

ARCODE = a finer measure of geographic location based on a county classification developed by the Appalachian Regional Commission. (See footnote 17). Hospitals were assigned codes within the range 1-10, where 10 indicates the most rural location and 1, the most urban. Codes 1-5 apply to the urban group, 6 and 7 to the middle group, and 8-10 to the rural group. The purpose of this variable is to better gauge how a hospital's geographic location affects its Medicare operating ratio.

PROF = a dummy variable taking the value of 1 if a hospital is for profit and 0 if voluntary or government.

VOL = a dummy variable taking the value of 1 if a hospital is voluntary and 0 if for-profit or government.

Hospital efficiency may be related to type of control. For-profit hospitals may, for obvious reasons, be more cost conscious than government and voluntary hospitals. Voluntary hospitals may, in turn, be more cost conscious than government hospitals because of the latter's access to public subsidy.

4. Results

Regression results for each of the geographic groups are presented in Table 2. A comparison of group means indicates that the urban group was, by far, the best compensated under the PPS, having a mean Medicare operating ratio for the period of .103. With a mean operating ratio of virtually zero, the rural group received the least adequate compensation. The middle group faired better, having a mean operating ratio of .033.[27]

The comparison of means does suggest that non-metropolitan hospitals received considerably less compensation than their metropolitan counterparts. The larger mean for the middle group in comparison to the rural group does not support the view that non-metropolitan hospitals nearer to urban were more adversely affected. However, a comparison of constant terms for the three groups sheds more light on the validity of this hypothesis. The constant term for the middle group is significant and negative while those for the rural and urban groups are not statistically different from zero. This suggests that base rates are less compensatory for the middle group than for the rural and urban groups.[28] Only base rates are affected by the metropolitan/non-metropolitan distinction. The base rates, however, are subject to a number of adjustments (case mix, wage, etc.) which apparently improve compensation for the middle group relative to the rural group.

SOLE and REFER, which apply to rural and middle group hospitals only, are in no instance significant. This finding suggests that the special payment under each of these designations does not result in compensation advantages or disadvantages. Thus, the PPS reimbursement methodology does not appear to be unfair with respect to these.

The coefficients of CMI are highly significant and positive for all three geographic groups. This finding suggests that hospitals treating costlier DRGs are more favorably compensated under the PPS. Specifically, DRG weights for lower cost DRGs seem to understate their true costs while those for higher cost DRGs seem to overstate.

The coefficients of WAGE are highly significant and negative for the middle and urban groups. It appears that the Medicare wage indices as they apply to these two groups are biased against hospitals located in areas with relatively high labor costs. The wage indices applicable to the rural group seem to operate fairly as indicated by WAGE's lack of significance for these hospitals.

The coefficients of OUT is also highly significant and negative for the middle and urban groups. The negative sign suggests that, for these groups, the outlier payments do not adequately compensate for the higher costs associated with these cases. Apparently, outlier payments are compensatory for the rural group (or outlier cases among these hospitals are too few in number to significantly affect Medicare operating ratios).

TCH is significant for the middle and urban groups only and the sign is positive in each instance. It seems that for these hospitals, the add-on for indirect teaching costs is more than adequate. The insignificance of TCH for the rural group is likely explained by the very few teaching hospitals in this group.

PASS is also significant for the middle and urban groups only. The negative sign indicates that Medicare compensation was less generous for hospitals with higher proportions of passthrough payments. Since passthroughs are cost reimbursed and earn zero profit margins, this finding is not surprising under circumstances where Medicare operating ratios were generally positive for the two groups. However, if DRG amounts were less compensatory and Medicare operating ratios were generally negative, a higher proportion of passthrough payments would become an advantage. The insignificance of PASS for the rural group is consistent with the virtually zero mean Medicare operating ratio for these hospitals.

KPASS is significant for the middle group only. The positive sign indicates that hospitals with a higher proportion of capital passthrough payments received more generous compensation under the PPS. This finding is consist with expectations. The present exclusion of capital costs from the DRG amounts may result in excessive reimbursement for hospitals that are more capital intensive. Such hospitals are likely to have lower labor costs but yet receive the same compensation for labor, through the DRG payments, as do more labor intensive hospitals. The lack of significance for the rural and urban groups may reflect considerably less variation in capital intensity among these hospitals.

BEDS is significant for the rural and urban groups. The positive sign for the rural group implies that Medicare payments were more compensatory for larger hospitals. Apparently, these hospitals experience considerable economies of scale and have lower costs per case. As noted, the PPS methodology does not adjust payments to reflect the effects of hospital size on costs. In contrast, the sign of BEDS is negative for the urban group. This finding is also plausible. Larger urban hospitals may treat more serious cases within each DRG and PPS outlier reimbursement may not adequately compensate for this. An alternative explanation is that larger urban hospitals may have higher costs because of over-expansion (in terms of facilities, equipment and scope of services).

OCCUP is significant and positive for the rural and middle groups. The positive sign indicates that PPS reimbursement was more compensatory for hospitals with higher occupancy rates. This finding is as expected since the PPS methodology does not adjust payments to reflect cost differences due to different occupancy levels. Because of fixed costs, low occupancy hospitals have higher costs per case and receive less adequate compensation. Lack of significance for the urban group may be explained by less variation in occupancy levels among these hospitals.

MDCR is insignificant for all three geographic groups. Apparently there are no cost advantages from specializing in Medicare cases.[29]

ARCODE is significant for the rural group only. The negative sign indicates that hospitals located in more geographically isolated counties received less adequate compensation under the PPS. Since occupancy, size, and other factors have been taken into account, the reasons for this relationship must be found elsewhere. One explanation is that isolated hospitals must offer a broader scope of services because their patients have less access to alternative facilities. This increases unit costs. The statistical significance of ARCODE also implies that the sole provider designation under the PPS is inadequate.[30] Lack of significance for the middle and urban groups indicates that geographic variations within these groups pose no advantages or disadvantages.

PROF is significant for all three groups while VOL is significant for the rural and middle groups. The sign is positive in each instance. These results are precisely as expected. The greater significance of PROF suggests that for-profit hospitals, because they are the most efficient, had the highest Medicare operating ratios, other things the same. Voluntary hospitals, though they seem to have experienced lower ratios than for-profits, clearly had higher ratios than government hospitals. Government hospitals appear to be the least efficient.

5.0 Discussion

Non-metropolitain hospitals have received less adequate compensation under the PPS than metropolitan hospitals. While this, in part, could be a result of the lower payment scales which seem to have particularly affected borderline non-metropolitain hospitals, it may also be explained by other aspects of the reimbursement methodology.

The regression results suggest several imbalances in the PPS methodology. Principal among these are those relating to the DRG weights and to the area wage adjustments. The evidence is strong that DRG weights are biased in favor of hospitals treating costlier DRGs. The presence of this bias was observed for all three geographic groups. Apparently, the DRG weights were determined in a manner that understates the relative costs of lower-cost DRGs. The specific reason for this imbalance is not clear. It is also unclear whether the imbalance is a consequence of some imperfection in the methods used to determine the weights or whether it reflects changes in DRG relative costs that have occurred since the weights were calculated. In any case, the weights should be re-examined to remove what appears to be an obvious bias in favor of higher cost DRGs.

The Medicare wage index seems biased against middle and urban hospitals located in areas with relatively high labor costs. Apparently, the data or methods used to determine these indices have resulted in an understatement of labor prices for these hospitals. An alternative explanation is that hospitals located in high labor cost areas also tend to be less efficient. However, there appears to be little theoretical justification for this interpretation. Medicare wage indices should be examined to determine the specific cause of this imbalance.[31]

The findings relating to outlier payments, the teaching add-on and the cost passthroughs, though of interest, are not surprising. The outlier payments were known not to fully compensate for the additional costs associated with outlier cases. Under the PPS, a trade-off exists between the adequacy of compensation for each case and hospital incentives for efficiency. Full compensation for outlier cases would undermine these incentives. However, the findings do suggest that some improvement in outlier reimbursement may be appropriate.[32]

The add-on for indirect teaching costs was known to have been more than generous. In fact, this was a deliberate attempt to minimize the risk of under-compensation faced by teaching hospitals. (See Prospective Payment Assessment Commission, 1988.) Steps have already been taken to reduce this payment adjustment to a more realistic level.[33]

The relationship between total cost passthroughs and Medicare operating ratios has already been discussed. A positive or negative relationship depends purely on whether the DRG amounts are compensatory. Therefore, this relationship per se is of no particular policy interest. The relationship between the capital passthrough and Medicare operating ratios does have policy relevance. The exclusion of capital costs from the DRG amounts causes capital intensive hospitals to receive excessive reimbursement (because no downward adjustment is made in the DRG amounts for lower labor costs). The need to eventually incorporate capital costs into the DRG amounts was recognized from the beginning. While this is scheduled to take place, in the interim to reduce the problem, capital costs are no longer fully reimbursed. The reimbursable portion is being gradually reduced from 100 percent and is scheduled to be 85 percent in FY 1989. (See Federal Register, May 27, 1988.)

Other findings pertain to hospital characteristics that were not recognized as appropriate bases for varying PPS payments. Hospital characteristics such as size and occupancy do seem to affect Medicare operating ratios. This does not necessarily mean that PPS payment scales should be modified to accommodate the underlying cost differences associated with these characteristics. To do so may undermine incentives for hospitals to become more efficient. However, in some instances hospitals may have little choice. For example, low occupancy rates among rural hospitals may to some degree be the unavoidable consequence of serving small isolated populations. These hospitals must maintain a sizeable stand-by capacity to meet fluctuations in demand. This is necessitated by poor access to alternative facilities. A similar argument applies to hospital size which may be improved upon only through centralization and reduced access for isolated rural populations. The findings also suggest that the costs of some rural hospitals may be higher for reasons other than small size and low occupancy. For example, the poorer access of their patients to alternative facilities may also require that they maintain a broader service capability. This may explain the negative relationship observed for the rural group between the degree of geographic isolation (as gauged by ARCODE) and Medicare operating ratios.[34] The effects of these factors on rural hospital costs should be more thoroughly investigated to determine if there is a significant basis for special treatment under the PPS.

Comparison of regression results across the three geographic groups reveals considerable differences in how they were affected by the reimbursement methodology. In general, the middle and urban groups seem to have been more affected by imbalances in the existing components of the methodology (CMI, WAGE, OUT, TCH, PASS, and KPASS). The rural group, on the other hand, seems to have been more affected by the absence of certain refinements in the methodology that would have resulted in a greater differentiation of payments (BEDS, OCCUP and ARCODE). Thus, the corrections that would result in fairer reimbursement vary across the geographic groups.

Conclusion

This study has investigated the fairness of the PPS reimbursement methodology. Several potential imperfections were found. These imperfections may have contributed to the variation in Medicare operating ratios observed among the different categories of hospitals. Not only is unbalanced compensation unfair, it can also lead to a an undesirable shifting of resources away from those areas and institutions that are adversely affected. This means that access and quality of care for some segments of the

Medicare population may be reduced. It is also important to note that the effects of these imbalances may become more acute as Medicare operating ratios generally fall (which they did during the period studied).

FOOTNOTES

[1] Some studies have focused on imperfections relating to specific components of the methodology, such as DRG categories and weights. However, no attempts were made to estimate the compensation effects of these imperfections. See, for example, Lave, 1985, and DesHarnais, 1988.

[2] The analysis in this paper is based on a study by Abt Associate, Inc., for the Appalachian Regional Commission. See Gianfrancesco, 1988.

[3] For a more detailed description of the PPS reimbursement methodology, the reader is referred to: Prospective Payment Assessment Commission, Technical Appendices to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services, April 1, 1985.

[4] There are over 400 DRGs used to differentiate Medicare payments.

[5] Costs per case for non-metropolitain hospitals historically have been lower resulting in lower rates for these hospitals.

[6] This is a weighted average of the DRG weights for the hospital's Medicare discharges in the base period.

[7] If this adjustment were not made, outlier payments would cause total DRG reimbursement to exceed the total cost of covered services.

[8] In calculating the regional and national components, the hospital-specific costs entering into the calculations are purified of case mix, wage and teaching effects. The purpose is either to remove costs that will later be added in determining DRG amounts (e.g., the indirect teaching adjustment) or to eliminate the variation in cost per discharge that is due to case mix and wage differences. This latter standardization is unnecessary for national costs but does remove differences among regional costs that are later accounted for in determining the DRG amounts applicable to each hospital.

[9] There is a unique wage index for each of the fifty states and for each of the few hundred metropolitan areas. Metropolitan area indices are applied to urban or metropolitan hospitals while state indices are applied to non-metropolitan hospitals.

[10] The outlier adjustment is the same as that applied to the hospital-specific component. The inflation update for regional and national costs initially differed from that for hospital-specific costs because of different base periods. However, in equation (1) for simplicity, we assume that it is the same.

[11] The weights have changed during each of the three PPS years under study, with that for the national component increasing and those for the regional and hospital-specific components decreasing. The regional and hospital-specific components of the base are scheduled to be phased out for most hospitals.

[12] Approximately 1,000 hospitals have been designated under the Medicare program as having some teaching function. The payment here is an add-on to cover the indirect costs attributtable to medical education. The add-on for each teaching hospital is determined using a formula applied to the hospital's ratio of residents and interns to beds and to the national and regional components (weighted) of its base rate.

[13] A hospital receives a DRG-specific outlier payment if a Medicare discharge exceeds a length-of-stay or cost threshold for its DRG category. The payment depends on the number of hospital days over the threshold and was at the rate of .6 times the cost per day for the period under study.

[14] See footnote no. 10.

[15] The data from this study are mostly from the Medicare cost reports that hospitals are required to submit to the Health Care Financing Administration (HFCA) on an annual basis. Other data relating to the PPS and used to determine DRG amounts were also obtained from HCFA. Abt Associates, Inc., because of its large contracts with HCFA, cleans and houses large amounts of data relating to the PPS.

[16] Not all hospitals are subject to Medicare DRG-based reimbursement. Excluded from the analysis are certain types of hospitals and hospital units that are or were exempt from the PPS during the study period: psychiatric, drug and alcohol abuse, rehabilitation, long-term and childrens. Also excluded from the analysis are all hospitals in the four states that were granted a PPS waiver because of the uniqueness of their hospital regulatory systems: Maryland, Massachusetts, New York and New Jersey.

[17] These distinctions were made using a county classification developed by the Appalachian regional Commission for all U.S. Counties. The classification is essentially based on population density and worker in-migration and out-migration. Each county was assigned a value within the range 1-10. A value of 1 indicates a central metropolitan county while a value of 10 indicates the most rural type of county. For the geographic groupings used in this study, urban includes codes 1-5; middle includes 6 and 7; and rural, 8-10.

[18] Hospitals did not implement the PPS at the same time. The first to do so implemented it in the last quarter of 1983. Others implemented it one to three quarters later. Implementation dates reflect hospital fiscal years. Since these begin in the last quarter of each calender year for the vast majority of hospitals, it is not unreasonable to assume that PPS1, PPS2 and PPS3 correspond approximately to 1984, 1985 and 1986. However, each hospital's Medicare operating ratio is calculated for its fiscal year and thus, corresponds to a stage of PPS reimbursement, where each stage applies different weights to the hospital-specific, regional and national costs used to determine Medicare payments.

[19] With respect to case mix, even if it were correlated with hospital efficiency, the DRG weights would incorporate this effect and it would not show up statistically.

[20] Since our interest is in cross-sectional differences in Medicare operating ratios rather than changes in these over time, this approach was

judged to be more appropriate than a pooled times series cross-section approach.

[21] As noted, non-metropolitan hospitals designated as sole community providers are reimbursed differently under the PPS. Specifically, they continue to be reimbursed in later PPS years under the formula applicable to the first year. (Hospital-specific costs were weighted more heavily in the first year.) This minimizes any adverse effects of averaging for this class of hospitals. Sole community providers, because they are less flexible in terms of service capacity, generally have higher unit costs in comparison to other non-metropolitan hospitals. Hospitals eligible for this classification had to have 50 beds or less at the time of this study.

[22] Rural referral centers are large non-metropolitan hospitals that receive a high proportion of transfers from other hospitals and thereby serve as rural centers. These also are subject to special reimbursement under the PPS. Specifically, they are paid the same rates as comparable metropolitan hospitals.

[23] This variable is not available from the Medicare cost reports. It was taken from a special Abt Associates file which currently includes indices for 1984 and 1985 only.

[24] See preceding footnote.

[25] Values for CMI and WAGE, since they reflect relative costs, are equal to 1 for hospitals that have the average case mix or wage cost. They range above 1 for those with a costlier case mix or wage cost and below 1 for those with a less costly case mix or wage cost.

[26] The objective of th PPS is both to encourage internal hospital efficiency and efficient changes in the structure of the industry. It would therefore be counter-productive to compensate hospitals in a way that undermines incentives for greater efficiency. However, if certain uncompensated hospital characteristics are unavoidable or largely so, then failure to compensate may lead to maldistributions of health care resources and reduced efficiency.

[27] The rural and middle group means seem inconsistent with those presented in Table 1. This however, is explained by the disaggregation in Table 1 which weights all bed size categories equally.

[28] It should be noted that a similar result might be observed if we distinguished an urban group further removed from the metropolitan/non-metropolitain border. This effect of the PPS is simply due to the grouping of hospitals with considerably different costs into broad geographic categories.

[29] Even if there were, this would not provide a clear basis for differentiating PPS payments. Such differentiations would undermine hospital incentives to lower costs by treating higher proportions of Medicare cases.

[30] The existing criteria for sole provider designation may exclude a significant number of rural hospitals that have higher costs because of geographic isolation.

[31] It should be noted that the wage index has already been corrected for a bias in the opposite direction. Part-time employees, who are paid lower rates, were originally weighted too heavily in determining hospital relative labor costs. Since part-time employees tend to be more prevalent among hospitals located in areas with lower wage costs, the bias was against these hospitals. Results from an earlier study by Abt Associates based on the first PPS year only clearly showed the presence of this bias. The coefficients of WAGE were positive and highly significant for all three geographic groups. (See Gianfrancesco, 1987.) The present results may reflect an over-correction of this earlier bias.

[32] Some improvements are in fact underway. The payments for cost outliers are scheduled to be increased from 60% of per diem cost to 80%. (See Federal Register, May 27, 1988.)

[33] The add-on for indirect teaching costs is scheduled to be reduced by about 30 percent in FY 1989.

34 The significance of bed size, occupancy and geographic isolation for the rural group together emphasize the inadequacy of the sole provider designation in meeting the special needs of all rural hospitals serving isolated populations.

References

DesHarnais, S.I. et al.: The Early Effects of the Prospective Payment System on Patient Utilization and the Quality of Care. Inquiry. 24, Spring 1987.

DesHarnais, S.I. et al.: Should DRG Assignment Be Based on AGE? Medical Care. 2(6), February 1988.

Feder, J., Hadley, J. and Zuckerman, S.: How Did Medicare's Prospective Payment System Affect Hospitals? New England Journal of Medicine. 317, October 1, 1987.

Federal Register. Vol. 53, No. 103. Washington, D.C.. U.S. Government Printing Office. May 27, 1988.

Gianfrancesco, F.: Appalachian Regional Commission Study of Rural Hospitals and Medicare Payments. Final Report for ARC Contract: 87-7/CO-9625-f86-Y1-302-0820. Washington, D.C., Abt Associates, Inc., October 1987.

Gianfrancesco, F.: The Financial and Behavioral Effects of the PPS on Different Geographic Groups of Hospitals. Final Report for ARC Contract: 87-157 CO-9625-87-Y2-302-0914. Washington, D.C., Abt Associates, Inc., September 1988.

Gutterman, S. and Dobson, A.: Impact of the Medicare Prospective Payment System for Hospitals. Health Care financing Review. 3(7), Spring 1986.

Lave, J. R.: Is Compression Occurring in DRG Prices? Inquiry. 22, Summer 1985.

Long, M. J. et al.: The Effects of the Prospective Payment System on Hospital Product and Productivity. Medical Care. 6(25), June 1987.

Prospective Payment Assessment Commission: Technical Appendices to the Report and Recommendations to the Secretary, DHSS. Washington, D.C., March 1, 1988.

TABLE 1
MEDICARE OPERATING RATIOS
PPS1 TO PPS3

All Hospitals

		Rural			Middle			Urban	
	PPS1	PPS2	PPS3	PPS1	PPS2	PPS3	PPS1	PPS2	PPS3
Beds									
<50	.007	-.018	-.111	.035	.016	-.089	.094	.086	-.014
51-100	.077	.067	-.013	.056	.045	-.021	.126	.119	.040
101-200	.091	.078	.020	.081	.075	.011	.136	.107	.040
>200	.095	.099	-.025	.078	.082	.018	.139	.126	.062

TABLE 2
ANALYSIS OF REGRESSION RESULTS MEDICARE OPERATING RATIOS
PPS1-PPS3

	Rural	Middle	Urban
N=	1073	859	1706
Mean Value of Dependent Variable, MOR:	-.0007	.0339	.1025
Independent Variables	Estimated Parameters (t statistics in parentheses)		
Constant	-.2714 (-1.419)	-.2932** (-2.146)	-.0425 (-1.088)
SOLE	.0023 (.098)	.0049 (.248)	
REFER	-.0915 (-1.054)	.0098 (.534)	
CMI	.6272*** (4.767)	.4770*** (5.835)	.2483*** (9.716)
WAGE	-.1822 (-1.310)	-.2064*** (-2.583)	-.0808*** (-3.266)
OUT	.0002 (.491)	-4.6528*** (-7.800)	-1.4261*** (-7.273)
TCH	6.7763 (.439)	3.2765* (1.883)	1.3023*** (6.305)
PASS	-1.1976 (-.474)	-2.5306*** (-4.244)	-.9562*** (-6.688)
KPASS	-.7944 (-.312)	1.5889*** (2.603)	.2411 (1.471)
BEDS	.0009*** (3.785)	-.0000 (-.497)	-.00005* (-1.669)
OCCUP	.0147* (1.642)	.2735*** (6.678)	.0135 (1.542)
MDCR	.0911 (1.260)	-.0712 (-1.320)	-.0176 (-.667)
ARCODE	-.0207** (-2.007)	.0017 (-1.320)	.0047 (1.477)
PROF	.1592*** (5.348)	.0978*** (5.632)	.0759*** (7.033)
VOL	.0554*** (3.423)	.0184* (1.716)	.0121 (1.439)
R^2	.15	.23	.16
F Ratio	12.860	18.530	27.652

*** Significant at .01 level
** Significant at .05 level
* Significant at .10 level

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES-- WHAT IS HOSPITAL COMPETITION?

Final Report

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EXECUTIVE SUMMARY

This paper discusses a concept (hospital competition) that has been used in many different contexts over the years with little agreement among the authors about the degree to which it exists, the means by which it may be conducted, or even the outcome(s) that might be expected. Some of the confusion arises because competition has a narrow meaning within the economics literature that is often confused with its more common usage, even by economists. This paper sorts out the major distinctions that must be made in any discussion of hospital competition.

The dictionary defines competition in business as being "between two firms...for the custom...(or business)...of a third party by the offer of the most favorable terms." This is the common usage of the word. Economists distinguish this competitive behavior of firms (the means by which they attract customers) from the competitiveness of the market structure in which the firms operate. The latter refers to the extent to which individual firms have power over the market to affect the terms of trade. A competitive market structure denotes a market in which no buyer or seller has any market power. Therefore, there is no competitive behavior in perfectly competitive markets (structurally defined) because, by definition, no firm has any power to influence the market by any of its actions.

Economists further distinguish among competitive behaviors that firms employ in their attempts to woo customers away from others. If hospitals compete by offering lower prices, economists speak of "price competition." "Non-price competition" denotes all other methods of competing, such as advertising, offering a differentiated product, or locational considerations among the rivals. Price and non-price competition refer to ways that hospitals attract customers. Thus the phrase "cost competition" is seen to be an oxymoron because there is nothing about cost per se that attracts patients to a hospital. What attracts patients are the attributes (such as better

nursing or nicer decor) for which the costs are incurred, not the costs themselves. Similarly, doctors are attracted by improved technology and more intensive staff support, which raise costs.

Hospital markets diverge from the perfectly competitive structural model of an industry in a number of ways. First, the scale of hospital operations is large relative to the size of the markets. Therefore, a competitively structured hospital market would be more costly than the market structures we currently have because of the duplication of services and facilities involved. Second, the hospitalization of most patients in this country is paid for through health insurance, which reduces the financial impact of any episode of treatment and reduces the patients' incentives to choose health care providers on the basis of price. The insurors have also historically been able to pass cost increases on to the employers and so have had little incentive to contain inflation in the health care sector. Third, physicians act as the agents of the patients, choosing the mode and, often, the location of treatment and have not often had incentives to base these decisions on the patient's price/quality trade off. Finally, consumers do not generally have the knowledge or information on which to base a decision about a health care provider, which increases their reliance on physician-agents.

These latter violations of the assumptions necessary for perfectly competitive markets also imply that non-price competition for patients will be more effective for hospitals than will price competition. Physicians and insured patients are unlikely to respond to reductions in prices but may choose a hospital because of other characteristics. For these reasons, hospital competition for insurors, physicians, and patients is expected to lead to higher costs, on average.

While competition is believed to have contributed to inflation of hospital costs in the last two decades, the reimbursement methods of both private and public insurors have also exacerbated the problem through their incentives to raise costs in order to raise subsequent reimbursement. Recent changes in reimbursement methods have put the hosptials more at risk for their financial status, increasing the pressure to contain costs more than might

otherwise be the case. This is not competition, however, because it does not directly affect the choices of consumers as to which hospital to go to for admission. The increased risk makes the X-inefficiency of operational slack in the hospital less attractive to hospital executives and gives them the incentive to contain costs.

There are four major conclusions of this paper.

1) A perfectly competitive market structure would raise average hospital costs; however, changing other structural elements would promote desirable competitive behavior among hospitals.

2) While price competition would prompt more cost containment in hospitals, medical insurance continues to reduce any responsiveness of patients' demand for hospital care.

3) Non-price competition among hospitals will continue to raise average costs in markets with more providers.

4) Changes in the price regulations for Medicare and other insurance programs will increase non-price competition among the providers because the hospitals are at more risk financially. In some markets this will offset the incentives to contain costs provided by the same regulations.

1.0 INTRODUCTION

1.1 Why Another Paper on Hospital Competition?

This paper discusses a concept (hospital competition) that has been used in many different contexts over the years. There is little agreement among many of the authors about the degree of competition that has existed between hospitals, the means of competition, or the outcome (either in the short or long run) that can be claimed for competition in this industry. For some, competition is the answer to any ill the industry suffers and leads to the lowest costs, highest quality, and most innovation. Others argue that competition among hospitals either raises costs above an economically efficient level or leads to lower quality in order to lower costs. Clearly, different policy prescriptions follow from these different conclusions.

Some of the confusion arises because competition has a narrow meaning within the economics literature that is often confused with its more common usage, even by economists. In addition, the term carries different ideological connotations for discussants with different political leanings. The purpose of this paper is to sort out the major distinctions that must be made in any discussion of hospital competition. This is done in hopes that it will enlighten the interpretation of the analyses of industry structure and hospital competition conducted as part of this project. After reading this, the reader will be wary of any use of the word competition that is not modified by a qualifying adjective or that does not have direct implications for patients or their doctors. When faced with an assertion that competition is good or bad, the reader should query "what kind of competition? Good or bad for what?" This is the reason for yet another paper on hospital competition.

This section presents the relevant definitions of competition (Section 1.2) and reviews their uses in the literature on hospital markets (Section 1.3). Section 2 is a discussion of hospital competition in the context of facilities' profit orientation and other missions that hospitals pursue. Section 3 outlines the ways in which hospitals compete. Finally,

Section 4 delineates the outcomes that are expected of competition in the hospital industry and the effect on costs in particular. Section 4 also contains a discussion of how these effects differ from these expected of fixed price regulation such as PPS.

1.2 Competition Defined

The dictionary defines competition in business as being "between two firms...for the custom ...(or business)... of a third party by the offer of the most favorable terms" (Webster's Second, 1955). This is the common usage of the word. By this standard an industry is competitive if firms are striving to secure customers through the lowest prices, highest quality, best service, and so forth. It is important to note that business competition, focuses on what attracts, or is favorable to, the customer.

Economists distinguish this competitive behavior of firms (the means by which they attract customers) from the competitiveness of the market structure in which the firms operate. The latter refers to the extent to which individual firms have power over the market to influence the price or other terms on which their product is sold. The conditions under which a market structure has a high degree of competitiveness are very restrictive. They denote a market in which no buyer or seller has any market power over the terms of trade. Therefore, there is no competitive behavior in perfectly competitive markets (structurally defined) because, by definition, no firm has any power to influence the market by any of its actions. This is the source of one semantic confusion in the literature when one author describes a market as competitive while another concludes that it is not. The first may be referring to firms' behavior while the latter draws a conclusion about the industry's structure.

Another source of confusion is that both competitive behavior and competitive structure are measured according to the degree to which certain actions or elements such as large numbers of buyers or sellers, information, etc., are present. Where one draws the line between large and small is a

matter of opinion. Therefore, one analyst could conclude that a market structure with ten firms is competitive while another does not. Similarly, to one expert, firms may be behaving very competitively while another sees the actions as moderately competitive conduct.

Economists further distinguish among competitive behaviors. If firms compete by offering lower prices, economists speak of "price competition." "Non-price competition" denotes all other methods of competing, such as advertising, offering a differentiated product, or locational considerations (either of the product on a store's shelves or of the store itself).

Analysts of all industries are ultimately interested in the structures of markets and the behavior of the firms in those markets because of the effects on consumers and society as a whole. The theoretical outcomes of different types of competition can be very different in terms of the quantities and qualities of goods produced and the prices at which they are sold. For example, the market structure that is labelled perfect competition leads to economically efficient outcomes while a profit maximizing monopolist with no ability to discriminate and no fear of entry will restrict output and raise price above the efficient level, in theory. However, some theoretical outcomes are ambiguous and in practice the performance of any market is difficult to evaluate.

While one may refer to the static equilibrium price and quantity in a competitive market as a "competitive outcome," it is inappropriate to define the degree of competition according to the desirability of the industry's performance. That is, a competitive industry or market is not simply one that gives the desired levels of price and quantity. In theory, the economically efficient price and quantity can be achieved under several market structures if the firms' conduct meets the right conditions. They are not all competitive markets, however.* The importance of this distinction for hospital policy is raised below.

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*For example, a perfectly discriminating monopolist can produce an economically efficient use of resources. Likewise, a regulated price set at the level that equates supply and demand is efficient. Neither of these desirable outcomes is the result of competition, either structural or behavioral, however.

1.3 The Use of the Term "Competition" in the Hospital Literature

Hospital competition has received a great deal of attention in the last ten years, but it has rarely been defined. One exception is in the annotated bibliography of Langwell, *et al*., (1982). There a competitive market is defined as

> "... one in which the structure of the market and the conduct of buyers and sellers causes prices to tend toward the lowest level at which sellers are willing to produce and offer goods and services." (p. 1).

This definition suffers from the shortcoming pointed out in Section 1.2 above: it defines the structure of the market and the conduct of the firms in it according to the outcome desired. Any market structure could be in keeping with this definition as long as the firms' conduct was restricted to price competition or as long as price was regulated effectively. A market in which a single buyer of medical services imposed the lowest price on all sellers would be considered competitive by this standard, even though it is not competitive in structure or in conduct by established norms. Further, the definition implicitly assumes away any other behavior of the firms, such as a reduction in the quality of the product (and, therefore, cost) or in the rate of innovation. Therefore, while it is appropriate to ask "What structure and conduct will result in the lowest hospital prices?" the definition cited above is unacceptable as a standard by which to measure the competitiveness of markets. Indeed it directly contradicts the definition used in earlier studies that show that "competitive" hospital markets are associated with higher average costs per case and, presumably, prices.

A few other articles state that the efficient use of resources (not price *per se*) is the desirable outcome of competition. These studies implicitly define competitive markets by the conduct of the hospitals to control utilization and costs. The competitive behavior is assumed to be the result of one or another element of market structure such as aggressive buyers (alternative health plans) or aggressive rival providers such as for-profit

hospitals, rather than from a large number of sellers having no power over the market. Implicit in these analyses is the assumption that without HMOs or for-profit hospitals the markets would be more costly because of lax management or non-price competition to attract patients.

To test the effects of these competitive behaviors, these studies compare a sample of either HMOs or for-profit hospitals to non-profit hospitals. The measure of efficiency is usually average cost (Watts and Klastorin, 1980), marginal cost (Feldman, et al., 1986), or average length of stay (Freund, et al., 1985). After controlling for other parameters affecting cost efficiency, the studies show that for-profit and non-profit hospitals behave similarly (Register, et al., 1985), that HMOs maintain lower costs but not lower rates of increase in costs (Luft, 1980), and that the market spillover effects from HMOs on efficiency are negligible (Merrill and McLaughlin, 1985). These findings have been hotly disputed, however. Some have contended that for-profit hospitals do have lower costs when the non-profits' tax-exempt status is properly taken into account but that other studies fail to do so.

However, these studies are analyses of neither competitive structure nor conduct. Competitive structure is explicitly ignored because the focus is on the conduct of the hospitals. The focus on firms' behaviors, however, is restricted to those that would reduce costs (i.e, whether one type of hospital is more efficient), according to the researchers, not on those that attract customers. Therefore, most of these studies really examine only the results of the profit motive or of capitated payment rates (received by HMOs) with respect to cost containment. Rarely is the competitive environment of the study hospitals examined.

An exception was the study by Merrill and McLaughlin which attempted to measure the competitive behavioral responses of providers to their rivals. The purpose of this competition is to raise product demand to more than offset the costs of the competitive tactics. As McLaughlin (1988) has concluded, the net result of the market environment where HMOs are present has been non-price competition (which raises costs), not price-competitive behavior or a competitive market structure.

In the last few years, a number of articles about hospital competition for doctors and patients have stressed the non-price aspects of these efforts and the results in terms of higher average costs. While these studies have used the number of hospitals in the market to define the degree of competition expected, it is competitive behavior they are trying to correlate with the performance of the hospitals, not the competitive market structure defined in microeconomic theory. The studies implicitly reject the notion that hospital markets might have competitive structures. Many market imperfections on the demand side (such as patients' lack of information, imperfect agents (doctors) buying care for patients, and the widespread reliance on third-party payers (both public and private insurers)) would make any claim of a perfectly competitive market untenable. On the supply-side, potential barriers arise from numerous government regulations that restrict the amounts of inputs, such as beds and doctors, and set prices. The question addressed in these studies is whether the number of sellers is positively correlated with non-price competitive conduct that raises the use of inputs and, consequently, costs.

Implicitly or explicitly, the studies test the hypothesis that the more rivals there are in a market, the more non-price competition there will be. Most notably, Robinson and Luft (1987), and Farley (1985) found that hospitals with the most competitors in the local area (eleven or more rivals within a 15-mile radius or more than five in the same metropolitan area) have higher average costs, holding constant wages, casemix, and other cost factors. This supports the hypothesis that hospitals in these areas, at least, compete by acquiring the latest technology, the most support staff, or the best amenities for patients or doctors. Luft, et al., (1986) extend the work in this vein by examining hospitals' provisions of specific clinical services and find that their acquisition was indeed more likely (in 1972) where the hospitals faced a greater number of competitors.

The point that hospitals compete by non-price methods has been so strongly made that at least one trade publication has highlighted it. "Will '88 be the year of price competition?" asked Hospitals magazine on Dec. 20, 1987. One year later, the answer is "No," although case studies with hospital

executives conducted from 1986 to 1988 confirm that there is considerably more price competition for outpatients (who are more likely to be paying for their services out of pocket) than for inpatients.* In addition, Melnick and Zwanziger (1988) and Robinson and Luft (1988) have reported results that support the conclusion that California's regulatory system, which has established a central authority to monitor hospitals' price bids to provide service to specific third-party payors, has been effective at lowering the rate of cost inflation, although only in the largest metropolitan areas.**

Reducing the rate of price increases is in keeping with Shleifer's (1985) notion of yardstick competition. In his regulatory system, firms are paid according to an average for comparable firms in the market or industry (PPS is cited as an example). For the result to be a first-best solution, however, the average regulatory price must be the marginal cost of an identical firm. Where average cost pricing is used, as in PPS, the outcome is at best a second-best solution and the resulting economic equilibrium may not be unique. This means that more than one set of prices and outputs may produce outcomes of equal economic efficiency but with potentially very different implications for patients differing with respect to diagnosis, income, or medical insurance. Nevertheless, this regulatory scheme represents an attainable standard that may yield better outcomes than an unattainable perfectly competitive solution.

However, is this competition? Where is the customer for whose busines the hospitals are vying? Can hospitals expect to add patients by cutting costs to meet an average cost regulatory price? This "competition" is

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*For example in Vermont Cromwell, _et al_., (1986) found "...some price competition in the ER, one hospital has lowered lab charges..." (p.7) In Iowa, "...emergency room and outpatient charges are determined more by competitive circumstances than inpatient charges..." (Pope, _et al_., 1986 p.10). In Albuquerque, "...Hospital financial officers universally agree that charges make no difference when it comes to competing for patients..." (Cromwell, Gaynor, _et al_., 1986, p.7).

**As Fuchs (1988) has noted, however, these hospitals had almost 50 percent higher expenses per admission, so it is not surprising that they would be affected more by average cost pricing and would therefore take greater measures to contain costs (p.11).

profit-maximization under price regulation instead. The use of the word "competition" to describe a regulatory system merely adds to the confusion that has been generated over the years by using the same word to cover market structure and all types of firms' behavior.

Similarly, referring to competition to contain costs confuses the issue because cost containment affects competition for patients only indirectly (e.g., through lower prices or lower levels of service). The efforts to contain hospital costs that have been observed following the implementation of PPS arise from differences in risk bearing by hospitals, particularly the risk of financial failure, due to the many changes that have occurred in recent years. The increased competition to fill beds or otherwise gain admissions continues to keep costs higher than they would otherwise be.

1.4 Conclusion

Analysts and policy makers concerned with any industry should be wary of the use of the term competition without a qualifying adjective, such as "price" or "non-price," or the use of the term competitive without the noun that it qualifies such as "structure" or "conduct." In the hospital literature in particular the term is widely used without modification and means many different things. This results in confusion, particularly for policy prescriptions. The reader should also beware that the use of the term competition with respect to hospitals and other producers of goods or services should relate to the firms' customers. One test for appropriate use of the term is whether adding the words "for patients," (as in "price (or non-price) competition for patients") makes sense. Where it does not (as in "cost competition for patients"), something other than competitive behavior or structure is intended. The reader should ask what this intent is.

2.0 WHAT ARE HOSPITALS COMPETING FOR?

In the English language, this title conveys two very different questions: 1) Why are hospitals competing? and 2) What is the goal of hospital competition? The definition of competition given in Section 1.2 above addresses the second question, not the first. The goal of competitive behavior is to attract the custom of a buyer. The reasons for doing this (the answers to "Why are hospitals competing?") are myriad.

In most industries, firms exist to earn a return on their owners' investments. This is also true for some hospitals. These compete for patients because they are necessary to make profits. If hospital A treats patient number 1, hospitals B and C cannot. It is a zero-sum game. Therefore, the three hospitals compete to attract patients through the most favorable terms of trade. However, in contrast, making profits is not a zero-sum game. Every firm in a market or an industry can make profits under certain circumstances (such as in a rapidly growing market or with collusion or if there is a shortage of a close substitute good). Likewise, every firm in a market or industry can make losses, in theory. A hospital with a net loss does not imply that there is another hospital with a high rate of profit, although there may be in practice.

Firms have goals in addition to that of making profits. Most of these goals can be transformed in the eyes of the beholders into larger concerns over profits, however. For example, the goal of growth is usually seen as a sacrifice of short-run profits for those in the longer run. Philanthropy on the part of most firms translates into a concern that the firm's image be a favorable one for customers who might buy the firm's products. Research and product development are goals that also can be transformed into long-run profit goals.

Not all hospitals, however, are like other firms in this respect. The profit motive certainly exists for hospitals, both those that are investor-owned and those that are not. Further, investor-owned hospitals are

thought to act much like other firms, seeking other goals (such as innovative medical programs) only to the extent that they contribute to the firms' long-run profitability. For not-for-profit hospitals, however, there may be other missions for which the hospital was founded and into which the profit motive can be translated. These include: medical research or teaching, helping the poor, and serving a particular denominational or geographic group. While these missions may not translate into profit seeking, they cannot be supported if the hospital does not receive enough revenues to cover its costs plus money for replacement or expansion. As one not-for-profit hospital administrator put it most succinctly: "No margin, no mission." However, financial margins need not be from operations alone. Not-for-profit hospitals frequently make up for operating losses through subsidies from government agencies, grants for teaching or research activities, and philanthropic fund-raising. Therefore, their competition for patients need not be totally constrained by the consideration whether a patient represents a financial loss to the hospital.

As in other industries, the concept of loss leaders for hospitals is raised frequently in conversations with executives. Experimental treatments, public relations programs such as smoking clinics, and obstetrics departments are sometimes cited as services for which the hospital loses money with the expectation that a favorable image will be created and future admissions will increase.

However, tight finances affect the hospital's ability to meet its other missions: many employees may have trouble serving the poor or doing good research if they are paid far below their peers; likewise, a hospital may have trouble sustaining a research program without funds to invest in equipment. Therefore, hospitals are expected, in economic theory, to try to perform efficiently, in the sense of minimizing the costs of fulfilling their missions. As Scherer (1980, p. 41) points out, however, to the extent that hospitals possess market power, they may tolerate organizational slack and raise prices instead. To the extent that a regulatory or other payment

program ensures that financial losses due to inefficiency will be covered, hospitals may pursue their other goals without great concern over a breakeven constraint.

If a regulatory program guarantees revenues, not only might hospitals not be technically efficient, they may not engage in competitive behavior. If losses due to inefficient use of capacity (high average costs due to the fixed costs of excess capacity, for example) are subsidized, why compete for customers for that capacity? The same profits can be realized without the effort. Therefore, a change in the regulatory structure that places hospitals more at risk for using their capacity or going out of business would be expected to increase the degree of competition (in the behavioral sense) in the market.

The existence of profit maximization on the part of the hospital or of a revenue constraint that limits the cost incurred by a hospital is thus important in determining the extent to which hospitals compete, either through pricing or by non-price means.* However, profit maximization also determines the extent to which a hospital monopolist would choose to exercise its market power to raise the charges paid by insurors or the lower quality of care received by patients. In either event, the search for increased profits must not be confused with increased competition for patients in analyzing hospital markets. The former is a motive for both competition and for the efficient production of services.

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*For theoretically optimal pricing that permits a public monopoly to breakeven financially see Baumol and Bradford (1970).

3.0 HOW DO HOSPITALS COMPETE?

Twenty-five years ago, hospitals were differentiated largely by their medical and nursing staffs, the newness of their technology, and whether or not they were teaching institutions. Some differentiation by religious affiliation also existed but many geographic markets were too small to support many different facilities. In this world, the patients' tastes in food, decoration, or other aspects of the accommodation were not important. In the large wards, patients were normally afforded privacy only by curtains that could be pulled around the bed. Hallways were covered with linoleum with walls of institutional yellow or green tiles to waist-level. They generally smelled of disinfectant.

Given the lack of amenities, competition for patients generally meant competition for physicians. Once a doctor was on the staff of a hospital, the patients would more or less follow because there were few differences among the facilities, from their point of view. In metropolitan areas, doctors might maintain admitting privileges at the competing religious institutions to accommodate those patients to whom this made a difference. Nevertheless, the conventional wisdom was that if the physician had strong preferences, the patient would comply. Therefore, hospitals competed for physicians by investing in equipment, supplying support staff, and otherwise meeting the demands of physicians who could fill the beds.

The norm has changed. Even the most prestigious institutions must take customers' tastes in comfort and decor into account in the 1980s. While physicians are still the mainstay of hospitals' competitive strategies, none of them can afford to fall far behind the market standards in providing privacy, appetizing meals, etc. The claim by hospital administrators that "We compete only for physicians" is frequently given the lie by recent renovations for private rooms, the addition of carpeting or the contracting out of the cafeteria services.

This section reviews hospitals' strategies to shift the demand and supply curves of their markets. Section 3.1 is concerned with competition directly for patients. Section 3.2 considers strategies for attracting and holding physicians. Finally, Section 3.3 explores the role of third-party payors in the competition for patients.

3.1 Direct Competition for Patients

The standard picture of a patient is of a passive, dependent person who has relinquished autonomy to professionals who choose the care the patient will receive. This patient enters the hospital only after consulting with his or her physician and being referred. Therefore, the physician controls the demand for hospital services even before the patient is admitted. Once in the hospital, of course, nothing is done for the patient without written orders by members of the medical care team. This picture is not in keeping with active competition aimed at patients. Should it be accepted as the norm?

The single largest source of hospital admissions is indeed from direct physician referral. Of almost 900,000 hospitalizations in Massachusetts in 1986, for example, 48 percent were referrals, not including emergency room admissions that were referrals to facilitate the admission of patients (Hendricks, et al., July 1988). (All women in labor may be admitted through the emergency room, for example, as a standard hospital practice. These should not be interpreted as non-referrals.) However, even physician referrals are more constrained than in previous years. Physicians with admitting privileges at several facilities are believed to consult with patients on their preferences. They are also limited in some instances by pre-admission requirements of the insurors.

Patients exercise some control over their choice of hospital when they are admitted through the emergency room, a setting often chosen by the patient for its proximity to the patient's house or the incident occasioning the admission. Patients also control the choice of hospitals to which they are admitted by their choices of a physician or insuror. Many physicians,

especially specialists, admit to only one hospital in their area and patients may be consciously choosing that hospital when they seek the care of that physician. However, hospital affiliation is only one of many factors that may affect a patient's choice.

In addition, the growth of alternative health plans such as health maintenance organizations (HMOs), preferred provider organizations (PPOs), and the like, may indicate people's preferences about hospitals. Those who enroll in HMOs are usually aware of the constraints that may be imposed on their hospitalizations. HMO enrollment forms indicate the names of hospitals with which the HMO is affiliated and many do not have contracts with all hospitals in their service areas. Thus, indirectly, the public is choosing a hospital through affiliations for health insurance. This is a marketing point that is emphasized by many HMOs and PPOs. On the other hand, traditional insurers such as Blue Cross and the commercial carriers direct their marketing messages at consumers who do not wish to have their choices of doctors or hospitals restricted. Even with the growth of HMOs in many markets, a plurality of hospitalizations in most states are covered by Blue Cross or a commercial carrier, indicating that much of the public may still prefer freedom of choice.

Most hospital competitive behavior to attract patients directly can be classified as non-price competition. That is, additional patients are gained not by lowering prices but by making the public believe that the hospital is better than its competition in some way, regardless of its price structure. It is not enough for the institution to acquire the latest technology, the public must know about it. Therefore, advertising and public relations are important.

Price competition does exist in hospital markets; however, it is price competition for outpatients more often than inpatients. While room charges and the prices of many ancillaries may have been raised in recent years, the charges for services provided on an outpatient basis have been reduced in many markets to expand the demand for laboratory services, fill clinics, and offset revenue losses due to declines in both admissions and inpatient lengths of stay.*

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*See for example, Cromwell _et al_.; Pope, _et al_.; and Gaynor, _et al_. cited in footnote above.

Why do administrators believe that the demand for outpatient services is price elastic while that for inpatients is inelastic? One reason is the greater out-of-pocket payment for outpatient services. A reduction is the charges for insured stays will not affect the patient's finances directly because the deductible or co-payment is often in fixed dollar amounts. In addition, the intensity of care provided on an inpatient basis is greater and this makes it harder to put off than a trip to the doctor's office. Finally, there are more substitutes for outpatient services while many complex surgeries either can be done only in the hospital or the patient believes that such is the case. The possibility of going to a doctor's office or clinic for the outpatient care strengthens a patient's position in getting more favorable service and prices from a hospital, at least in theory. However, direct competition for inpatient admissions remains largely on a non-price basis.

3.2 Direct Competition for Physicians

What makes a doctor choose affiliation with one hospital rather than another? Economists cover all possible reasons under the term utility maximization. Because it applies to non-pecuniary as well as pecuniary considerations, it is preferable to income maximization as an explanation.

Maximizing income is a primary reason, however. Affiliation at some hospitals confers prestige on physicians and therefore may allow them to charge higher fees (Custer, 1986). The public may assume implicit peer review in the affiliation and the more prestigious the institution, the greater the implied physician quality. This implies that patients choose physicians because of the hospitals they wish to be admitted to rather than passively accepting the choice of hospital because they have chosen a doctor, however.

Hospital affiliation can maximize a physician's income in other ways, as well. Hospital affiliation leads to referrals from colleagues, for example, and the larger the hospital, the more referrals there may be. Hospital services may also substitute for resources that the doctor would have had to

supply in his or her own practice, reducing costs and raising net income, or permitting the physician to perform additional services more easily and thus add to net revenues. The presence of medical residents or of other doctors on call allows the doctor to spend time on other income-producing activities. The right affiliation may also reduce the doctor's transportation costs, by consolidating his or her hospital visits. Therefore, many physicians' offices are located near the hospital to which the physicians admit the most patients.

On the non-pecuniary side, hospital affiliation also provides physicians with a community of peers. The importance of this cannot be ignored, especially in rural areas. The success of rural hospitals' recruitment strategies is often determined by the extent and nature of the community of physicians into which a new doctor would come. Where such a community is not present, new doctors often refuse to accept or remain in jobs.*

Physicians may also share non-pecuniary goals with a hospital. For example, they may wish to pursue a life of research, teaching, or helping the poor, with or without a goal of maximizing their incomes. To attract these doctors, the hospitals would have to supply the equipment and personnel needed for the research or teaching activities, as well as attract the patients for the research or teaching program. Where in the last century doctors might have funded these activities out of their own incomes, the programs of today are so expensive that no single practitioner or even group of doctors could expect to pay for them, even if they wished to. This is another dimension of the competition for physicians.

This competition directly for physicians and indirectly for patients has the effect of raising costs because of the additional personnel and equipment required. Pauly (1974), building on the model of Pauly and Redisch (1973), found a positive relationhip between physician income and hospital capital investment. This is consistent with the view here that competition for doctors would raise hospital costs. It will not lead to lower prices because

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*See Hendricks (1988) for a discussion of how this has affected rural hospitals.

there is a presumption that physicians do not choose to admit to a hospital because of the prices it charges in general, although they may care about the availability of care for the indigent. The higher costs may or may not lead to higher prices, depending on the hospital's ability to raise non-operating revenues. However, higher costs coupled with stable prices would mean reduced financial margins. On the other hand, when insurors have based their reimbursement formulas on costs, competition that raised costs raised effective prices, as well.

3.3 Competition for Insurors

The fact that a patient has health insurance ensures that the doctor and the hospital will be paid something for their services. The advent of insurance programs during the depression of the 1930s constituted a revolution, of sorts, for these providers. (See Starr, 1982, especially pp. 295-310). Insurance solves the providers' collection problems (Glaser, 1987, p. 108-9). Therefore, insured patients are more sought after, in general, than those who pay for themselves. The fact that many of those without insurance also have low incomes compounds this preference for treating insured patients. Finally, public insurance programs are not always as lucrative for the providers as private insurance is. Patients on Medicaid, especially, are less desirable from a financial viewpoint and competed for less.

Until health maintenance organizations and other alternatives to more traditional health insurance became a factor in hospital markets, however, competition for the insured was directed at the physician or patient. Insurors compete with each other on the extent of benefits and access to care. Therefore they have not been able to guarantee volumes of patients to hospitals in return for more favorable rates. Patients choose, with their doctors, where to be admitted. Further, among the insurors, only Blue Cross has represented a sizeable enough number of enrollees to present a strong bargaining position vis-a-vis any one hospital (Glaser, p. 112). However,

forming a common negotiating team violates antitrust laws except where states have instituted an all-payer regulatory system.

Offering more favorable terms of trade to the insuror is becoming more commonplace as the insurors themselves compete for business through lower premiums to employers and must be more concerned with containing their costs. Some of this competition is engendered by the growth in health maintenance and preferred provider organizations in the largest urban markets. However, until the insurors have developed the experience and data required for effective negotiations, other means of cost containment, such as readmission approval and utilization review programs, are more effective in containing costs.

4.0 THE OUTCOMES OF COMPETITION

We have seen above that the term competition encompasses market structure and two very different types of firm behavior: price and non-price competition. Because of these dualities in the use of the term (structure versus behavior, emphasis on price versus non-price aspects of the terms of trade), the question is not whether competition should be promoted but which kind of competition is desirable. The answer depends on what one is trying to achieve.

This chapter addresses this question by examining the outcomes that can be expected of each type of competition for industries in general and the hospital industry in particular. The cost outcome is the focus with respect to each type of competition because cost containment is one of the primary concerns of public and private policymakers. Despite this focus, other concerns cannot be ignored, especially those of quality, innovation, choice, and equity.

4.1 Competitive Structure and Costs

The optimal, that is economically efficient, use of resources is assured by a market structure characterized by perfect competition. Such a market contains so many buyers and sellers (and conforms to a number of other conditions) that no economic agents have the power to significantly affect the terms of trade. Therefore, the price and quantity outcomes of perfectly competitive markets are used as a standard by which the price and quantity results in markets with other structures are judged.

Many industries would not be optimally served by a perfectly competitive market, however, because the scale required for minimal production costs can be achieved only by a few, relatively large producers. For these industries, perfect competition would actually raise costs, and therefore prices to consumers, because it would require many small firms, each with higher average costs due to an inefficient scale of production.

Hospital markets conform to this pattern. The scale of production that is required is large relative to the size of the market. For this reason, hospital markets are heavily concentrated. For example, over half of all rural counties with hospitals contain a monopoly and none has more than six facilities. Half the nation's metropolitan areas contain no more than five hospitals and three quarters have no more than nine. This does not mean that there can be no small facilities but that such hospitals will be restricted in their abilities to offer special services because of the scale needed to support certain types of equipment.

Given these conditions for producing hospital services, perfect competition (a market structure requiring many hospitals that are small relative to the size of the market) would raise costs and prices compared to current levels. Indeed, some would argue that there are still too many small, inefficiently sized facilities and that many markets require more consolidation of existing hospitals to ensure cost savings. These arguments receive considerable support from the fact that most of the hospitals that have closed during the 1980s are small, averaging fewer than 50 beds in the post-PPS era especially, with above average costs per case (see Hendricks, Dresser, et al., 1988).

The conclusion is that a competitive structure for hospital markets is not desirable. This does not mean that other structural elements should not be changed but the reason to do so is to promote certain types of competitive behavior among hospitals, not a competitive structure for the hospital markets.

4.2 Competitive Behavior and Cost

Firms can behave competitively with respect to both price and non-price aspects of their goods or services. Their concern is to find which competitive strategies appeal to enough customers to increase net revenues. Hospitals are no exception to this, although the prevalence of third-party payment and the uncertainties over quality for a potentially life-and-death

service heighten the importance of non-price competition for patients. The outcomes of these types of behavior with respect to costs are very different, however.

4.2.1 Price Competition and Costs

For the past two decades or more, hospitals have generally been paid for inpatient admissions on the basis of their costs or some variant thereof. If the insurors had no standards concerning the quantities of supplies or procedures used in treating someone, the most that they could hope to control was the price they paid per unit of service supplied by the hospital. Some did not attempt this and merely passed increased costs along to consumers in higher insurance premiums. Other payors, including governments, tried to determine and pay only a "reasonable cost" for each item. Still others, those with some buyer power in the market such as Blue Cross, negotiated a fixed discount from listed charges.

These methods of reimbursement gave the hospital industry no incentive to control the amount of services used for any one admission, because the additional supplies or procedures would be covered by the insurance. The patient also had little incentive to demand fewer services because the charges above the deductible were often virtually free from his or her point of view, or at least came at a much reduced charge. Furthermore, the hospitals had no great incentive to control the inflation of costs because those would be incorporated into either their charges or the payment formulas of the insuror and would eventually be covered. Both the increased costs per unit and any increases in the numbers of services provided to patients increased the costs of hospital care and of insurance.

While past reimbursement methods contributed to the lack of price competition and to higher costs in the hospital industry, changes in reimbursement such as Medicare's prospective payment will not lead to price competition, as long as there is no threat of losing patients because of high

prices nor a promise of gaining cases by lowering charges. To bring about actual competition, a payor must be able to guarantee that the patients will go only to those providers with the best terms. Medicare and many private insurance companies cannot do this, as yet, for fear of the public's reaction.

For Medicare, the reaction of the public would take a political form while insurance companies would fear the loss of business from consumers who prefer no restrictions on their access to care. Some alternative health plans are able to market effectively to consumers while restricting access to those providers with favorable charges. In addition, California is involved in an experiment to increase the amount of price competition among its hospitals through a state-mediated bargaining sytem, although whether this has had the desired effect on containing hospital costs in that state is debatable.

By putting the hospitals more at risk for their financial status, prospective payment does increase the pressure on the hospitals to contain costs more than might otherwise be the case. This is not competition, however, because it does not directly affect the choices of consumers as to which hospital to go to for admission. The increased risk makes the X-inefficiency of operational slack in the hospital less attractive and gives a hospital the incentive to contain its costs.

The extent to which real price competition among hospitals would lead to a desirable outcome depends on the ability of the consumers' agent (an insurance company or government official) to monitor and perhaps publicize the quality of care that would be received for a given price. Price competition in any industry presumes a given level of quality. For manufactured goods that are already in inventory, this poses no problem. For customized service goods, however, there are many opportunities to alter the nature of the service after a price has been agreed upon. For a competitive solution to be optimal from the consumers' point of view, there must be a way to check that the nature or quality of the product is not altered in undesirable ways when the price is reduced.

For hospital care, the major concern is that medical quality not be compromised as a result of holding down hospitals' prices. Reductions in other amenities for the sake of containing costs might be optimal for many patients while those demanding more would presumably pay an additional amount for them. To effect such a change, however, the insurors or other bargaining agents would need to be able to monitor medical quality and assure the public that there has not been a compromise that could endanger people's health. If hospitals are perceived to cut service or quality more than they cut prices, the patient population might choose other insurors or, in the case of Medicare, register their dissatisfaction with the Congress. Quality is thus the Achilles' heel of real price competition. Without monitoring, price competition will not necessarily bring about an optimal level of hospital services because of the problem of asymmetric information and attendant problems of market failure. Lower prices to draw in patients may be accompanied by undesirable changes in the services provided.

4.2.2 Non-Price Competition and Costs

Almost all types of non-price competition are likely to raise the costs of production, no matter what industry we are considering. Advertising, raising quality, adding options to the mix of characteristics that people want to purchase, all require resources that must be paid for. Exceptions to this generalization would include instances where the competition leads to increased volume which in turn allows the firm to benefit from economies of scale or scope. What is true for an individual firm in this respect is not necessarily true for the industry as a whole, however. (The fallacy of composition.)

Another form of non-price competition that may not raise costs is the choice of a convenient location. This is problematic, however, because the price of desirable locations may be bid up, raising the costs of doing business there. In the hospital industry, this may indeed be a factor in large cities.

Encouraging non-price competition is not an effective way to ensure the lowest costs for any product. Further, in the hospital industry this form of competition is undoubtedly here to stay. While the intensity with which non-price competition has been pursued may decrease with changes in reimbursement systems, patients with insurance and/or high incomes will continue to exert pressure on hospitals to provide better accommodations and nursing as well as maintain high standards of medical care. All other things being equal, this is a good thing. It implies that some hospitals, which feel these pressures more, may continue to have higher costs than their peers. Exerting pressures to contain costs will reduce the differential that may be due to non-price competition and the combination may at least eliminate X-inefficiency in hospitals.

4.3 Fixed-Price Regulation

The many changes in the medical industry, particularly the changes in reimbursement for Medicare, Medicaid and many private insurors, have undoubtedly increased the degree of competitive behavior between hospitals in many, but not all, geographic markets. Some of this competition is through lower prices but most is non-price competition, including advertising, increased amenities, public relations, renovations, etc. The pressures to compete for patients are primarily engendered by the fact that hospitals are increasingly at risk for their own financial well-being and cannot rely on passing on fixed costs to insurors when inpatient censuses fall.

The point has been made above that increased non-price competition is not a means to contain costs. Price competition would be, but the fixed regulated prices of Medicare's prospective payment is not a spur to price competition. To what extent is it a spur to cost containment, as policymakers hoped? The answer depends on the characteristics of each market: the effect of paying the national average will be different in markets where all hospitals are below that average (rural Alabama) compared to markets in which

all hospitals are above the average (California cities) or markets with hospitals that are both above and below the average.

The latter are perhaps what policymakers had in mind when PPS was implemented. An average price would give the above-average cost hospitals an incentive to lower, or at least contain, costs. The below-average cost facilities would have the wherewithal to expand their services, quality, or physical plants and be in a more competitive position. Given budget neutrality, the real savings to the Medicare system would come through reduced inflation rates, and therefore lower increases in the fixed regulatory prices.

Where virtually all of the hospitals in a market area are either above or below the average (standardized for casemix, etc.) the competitive conditions thwart the nice scenario envisioned for cost containment. Many low cost hospitals are monopolies or in very concentrated markets. These low-cost providers may already have the majority share of their markets. Further, the population base is often too small to support expansion plans and the economic conditions often do not support them either.

The conditions for high-cost providers may vary more. Small rural hospitals with monopolies are disproportionately among the high-cost group. Their costs appear to be driven by the need to average high fixed costs over a dwindling patient base. These providers may be least able to reduce their costs in the intermediate term to breakeven on their Medicare caseloads. The other high-cost markets tend to be in large urban areas with the potential for significant amounts of non-price rivalry. These hospitals may all need to reduce average costs to breakeven under fixed price regulation but may be unable to do so because of the competition for patients.

The notion that the new regulatory scheme of prospective payment can be labelled "cost competition" fails to recognize that the latter phrase is an oxymoron. Competitive behavior denotes vying for the business of patients and doctors by offering better terms of trade. Hospitals cannot expect the demand for their services to increase because they have reduced their costs. If anything, cost reductions are likely to reduce demand, therefore it is

important that hospitals not reduce their positions relative to those of their competitors. If cost reductions allow hospitals to be more competitive in terms of their prices, real competition is served but it is price competition.

REFERENCES

Baumol, W.J., and D.F. Bradford, "Optimal Departures from Marginal Cost Pricing," American Economic Review, June 1970, 60, 265-83.

Cromwell, Jerry, Gary Gaumer, Judy Williams, and Andrea Hassol, "Case Study Site Report: Northwest Vermont," National Hospital Payment Evaluation, HCFA Contract No. 500-85-0015, September 1986.

Cromwell, Jerry, Martin Gaynor, Judith Williams, and Brooke Harrow, "Case Study Site Report: Albuquerque, New Mexico, National Hospital Prospective Payment Evaluation, HCFA Contract No. 500-85-0015, October 1986.

Custer, William S., "Hospital Attributes and Physician Prices," Southern Ecomomic Journal, (52)4:1010-1027, April, 1986.

Dennis, Kenneth G., Competition in the History of Economic Thought, New York: Arno Press, 1972.

Farley, Dean E., "Competition Among Hospitals: Market Structure and its Relation to Utilization, Costs and Financial Position," Research Note 7, Hospital Studies Program, DHHS Publication No. (PHS) 85-3353. U.S. Department of Health and Human Services, National Center for Health Services Research and Health Care Technology Assessment, 1985.

Feldman, Roger et al., "The Competitive Impact of Health Maintenance Organizations on Hospital Finances: An Exploratory Study," Journal of Health Politics, Policy and Law, (10)4:675-697, Winter, 1986.

Freund, Deborah et al., "Analysis of Length-of-Stay Differences Between Investor-Owned and Voluntary Hospitals," Inquiry, (22)1:33-44, Spring, 1985.

Fuchs, Victor R., "The 'Competition Revolution' in Health Care," Health Affairs, Summer 1988, 7, 5-24.

Glaser, William A., Paying the Hopital: The Organization, Dynamics, and Effects of Differing Financial Arrangements, San Francisco: Jossey-Bass Publishers, 1987.

Hendricks, Ann., "The Prospective Payment System's Impacts on Rural Hospitals: Overview of Nine Case Studies," HCFA Cooperative Agreement No. 17-C-99102/01, November 1988.

Hendricks, Ann M., Elliot M. Stone, and Catherine B. Comstock, "Measures of Local Hospital Markets," paper presented at Western Economics Association, July 1988.

Hibbard, Judith H. and Edward C. Weeks, "Consumers in a Competition-based Cost Containment Environment," Journal of Public Health Policy, Summer 1988, 9, 233-249.

Langwell, Kathryn M. et al., An Annotated Bibliography of Competition in the Financing and Delivery of Health Services, DHHS Publication No. (PHS)83-3326, NCHSR Research Report Series, October, 1982.

Luft, Harold S., "Trends in Medical Care Costs," Medical Care, (18)1:1-16, 1980.

Melnick, Glenn A., and Jack Zwanziger, "Hospital Behavior Under Competition and Cost-Containment Policies: The California Experience, 1980 to 1985," Journal of American Medical Association, (260)18:2669-2675, 1988.

Merrill, Jeffrey and Catherine McLaughlin, "Competition Versus Regulation: Some Empirical Evidence," Journal of Health Politics, Policy and Law, (10)4:613-623, Winter, 1986.

Pauly, M., "Hospital Capital Investment: The Roles of Demand, Profits and Physicians," Journal of Human Resources, (9) 1:7-20, Winter 1974.

Pauly, M., and M. Redisch, "The Not-for-Profit Hospital as a Physicians Cooperative," American Economic Review (63) 1:87-99, March 1973.

Pope, Gregory, Carol Carter, David Juba, and Ray Glazier "Case Study Site Report: Northeastern Iowa," National Hospital Prospective Payment Evaluation, HCFA Contract No. 500-85-0015, November 1986.

Register, Charles V., Ansel M. Sharp, and David G. Bivin, "Profit Incentives and the Hospital Industry: Are We Expecting Too Much?," Health Services Research, (20)2:225-241, 1985.

Robinson, J.C., and H.S. Luft, "Competition and the Cost of Hospital Care, 1972 to 1982," Journal of the American Medical Asociation, 257, 3241-3245, 1987.

Robinson, James C., and Harold S. Luft, "Competion, Regulation, and Hospital Costs, 1982 to 1986," Journal of American Medical Association, (260)18:2676-2681, 1988.

Scherer, F.M., Industrial market structure and economic performance, Second Edition , Chicago: Rand McNally College Publishing Company, 1980.

Shleifer, Andrei, "A theory of yardstick competition," Rand Journal of Economics, (16)3:319-327, 1985.

Starr, Paul, The Social Transformation of American Medicare, New York: Basic Books, Inc., Publishers, 1982.

Watts, Carolyn A. and T. D. Klastorin, "The Impact of Case Mix on Hospital Cost: A Comparative Analysis," Inquiry, (17)4:357-367, Winter, 1980.

Webster's New International Dictionary of the English Language Second Edition, Unabridged, Springfield, Mass: G. & C. Merriam Company, Publishers, 1955.

EVALUATING HOSPITAL MARKETS

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES-- HOSPITAL MARKET STRUCTURES AND PPS

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REFERENCES

1.0 INTRODUCTION

Industries and markets differ in many important ways that can affect the prices consumers pay and the quantities of goods available to them. For example, some industries consist of many producers; others, very few. The effect of very few producers, economic theory suggests, is higher prices and fewer goods than would otherwise be the case. Low barriers to entry, however, can encourage firms to enter markets with high process and profits, potentially offsetting the market power of existing firms and leading to lower prices and more goods.

These characteristics, the number of sellers and barriers to entry, are two elements of market structure. Market structures vary in their degree of competitiveness, the extent to which individual firms have power to influence price or other terms of trade in the market. Market structure can therefore affect the competitive behavior of firms in that market, and consequently the well-being of consumers, through the quality and quantity of goods produced, the prices paid for them, and the innovation in the industry as a whole. An understanding of the market structure of an industry is important to the study of its economic performance, especially when issues of public policy are involved. Changes in policy may affect both the structure and conduct in the industry and produce outcomes that were not intended.

This paper explores the relationship of the structure of hospital markets to hospitals' average costs and to changes in those costs in the first three years of Medicare's prospective payment system (PPS). These analyses are part of a larger evaluation of the impact of PPS on the nation's hospital industry. This chapter discusses the types of market structures, outlines the elements of market structure, both in general and for hospitals, and briefly reviews the literature on hospital markets and outcomes. Chapter 2 describes the data used in the empirical work. Hospital markets are described in Chapter 3, while multivariate regression analysis of average costs, relating

them to market structure, is the topic of Chapter 4. Chapter 4 also examines the relationship of structure to changes in costs and lengths of stay, and to financial measures. Finally, it shows how market structure has changed since 1983.

1.1 Types Of Market Structure

Despite its many facets, market structure is usually classified in one of three ways. The most common classification scheme is according to the number of sellers - from one to a large number. These categories assume a large number of buyers but a market with buyer concentration may have different firm behavior. Other elements also affect both structure and conduct.

Industries with structures characterized as perfect competition have many sellers as well as buyers. The product is homogeneous, so there can be no preference of one firm's product over another. In addition, there are no artificial restraints, which means that price fixing and rationing do not exist, for example. Prices and supplies of commodities are free to change according to market conditions. There is no barrier to entry. A firm can enter or leave the industry without any restrictions. Last, there is perfect knowledge of market conditions among all buyers and sellers. Under these highly restrictive assumptions, it should be noted, there can be no competitive behavior if the market has a perfectly competitive structure. Nothing a seller can do can increase the firm's market share.

Hospital markets are never competitive in this structural sense. Instead, they tend to be oligopolies. The latter is characterized by a few sellers with differentiated products. Entry is limited to many barriers such as large fixed costs for patents, production, and advertising (in the United States, at least). The firms in an oligopoly are often interdependent, in the sense that the actions of any one of them will affect the others in a major way.* In theory, oligopolies are thought to be conducive to collusion among

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*This contrasts markedly with perfectly competitive firms which are so small relative to the market that no expansion or contraction by any one of them can be detected by others.

the few sellers to restrict production and raise prices, although in practice there can be many mitigating factors. Because of the potential for collusion, oligopolies have been a major focus of U.S. industrial policy, particularly antitrust laws. Because they have many possible competitive strategies (including advertising, product differentiation, location, etc.) they are of particular interest to industrial economists.

Product differentiation is the major distinction between perfectly and monopolistically competitive markets. Both can have many firms with freedom of entry and exit but the fact that the product is not identical across all firms implies that each firm has some power over the terms of trade (price and quality) of its own product. In manufacturing industries, such differentiation (filling niches of consumer desires) is a strategy for oligopolists but in service industries, each firm can be differentiated in this way. Monopolistic competition appears to characterize hospital markets.

In the market definitions above, the number of buyers was assumed to be very large. Therefore, no buyer or group of buyers could possess market power. If the number of sellers is limited, the market price and quantity are theoretically indeterminate. The outcome depends on the startegies of both sides. If the buyer can play sellers off against one another, the terms of the market will be more favorable for the buyer than the sellers. If the sellers present a united front, the outcome will be different. In addition, the more differentiated the product, the more the potential outcomes will vary and dynamic strategies will matter more. If there are a few buyers, rather than one, market predictions are similarly interdeterminate. Buyer power is important in hospital markets. while many insurors have not effecitvely wielded their market power to contain costs, HMOs and Medicare have begun to exercise their power. The results are the topic of this paper.

1.2 Elements Of Hospital Market Structure

There are several elements of structure: the number of buyers and sellers, barriers to entry and exit, product differentiation, the absence of

artificial restraints, the extent of vertical integration and the availability of information. The most important of these elements in determining the competitiveness of market structure are the numbers of buyers and sellers, which were highlighted in the discussion above. The other elements also determine the competitiveness of a market, however, because they determine the competitive strategies that firms will find profitable.

The hospital industry differs from many others in several respects. The hospital supplies services to patients which are demanded largely by the patients' agent (a doctor) and paid for primarily by insurors (whether public or private). This separation of demand and payment tends to make hospital utilization a price-inelastic good. Hospitals are heavily regulated in most states with respect to building codes and licensing as well as the prices paid by public programs. In addition, information on product quality is difficult to obtain or interpret, leading patients to use price as a signal or proxy for quality, in many instances.

The fact that hospital services can be combined to treat many different kinds of diseases makes this a multiproduct industry. The individual differences in patients requires customized services to a large extent even though many aspects of them are routine. The markets for some of these services are local while others are not. A patient may go to the nearest hospital for care that does not require the use of highly specialized services. A patient requiring the care of specialists, however, may choose to travel across the country to get treatment. This difference complicates analysis of hospital markets because it makes it difficult to define the correct number of sellers in a given market.

Hospitals compete with each other for physicians and patients. Investing in certain services may attract physicians and, in turn, their patients. Other factors, such as location, also affect physicians' and patients' choices of hospitals. Differences in hospitals' behavior are thought to be caused in part, by the differences in the market structures. A monopoly hospital does not need to differentiate its location or service. However, few hospitals are free of competitive pressures any more.

Image building, a type of advertising, is important in the hospital industry. A hospital differentiates itself by advertising that it has new technology or services and the best physicians and staff, for example. However, it is very difficult for a hospital to convey this information because medical jargon is not easily understood by lay people.

The analysis in sections 3 and 4 below describe hospital markets with respect to a number of structural elements that are believed to be important determinants of hospital behavior. In addition to the number and market shares of the sellers, section 3 describes the extent of horizontal integration within markets that is due to multihospital system affiliations in those markets. The degrees of market entry and exit are also examined to indicate areas where the market structure may be more competitive.

While advertising competition among hospitals cannot be measured, the differentiation of the most prestigious hospitals can be. Flagship hospitals that offer super-tertiary services can be identified as one measure of the extent of differentiation within hospital markets.

Finally, the concentration of buyers is an important element. While patients have little market power with hospitals, insurers may, especially if they cover a large proportion of the market. To this end, the extent of penetration by alternative health plans is measured to indicate markets in which countervailing buyer power may exist.

2.0 DATA AND FILE CONSTRUCTION

Three databases were used for this report on the market structure of the hospital industry. The first was a dataset of all non-federal, acute-care hospitals in the United States existing between 1980 and 1986. For this, records were merged from three sources to obtain the universe of the acute-care hospital industry. The second was a merged file of Medicare Cost Reports and data from the American Hospital Association (AHA) annual surveys. Hospitals' fiscal years covered by the regulations under TEFRA and the first three years of the prospective payment system were included in this file. A third file containing information from the 1988 AHA Guide on multihospital systems that existed in 1987 was constructed and merged to both the first and second data files. The universe file is discussed in A.1 while the analytic file for TEFRA through PPS-3 is described in A.2. Possible biases in the analytic file for TEFRA-PPS-3 are discussed in A.3. The systems datafile is the subject of A.4.

2.1 The Universe File

2.1.1 Data Sources

Hospital records were obtained from three sources: the AHA annual surveys, Medicare Cost Reports (HCRIS) and HCFA's Provider of Service (POS) file. These three databases included any available information on the hospital's name, the unique AHA hospital identification code (hospid), location, ownership, personnel, utilization, reporting procedures, expenses, admissions, number and type of beds, length of stay, Medicare participation, HMO participation, and affiliations. From the Area Resource File (ARF), the final database also included some demographic information on the population of the county in which each hospital was located. The universe file consists of

38,580 hospital-level records sorted by state, hospid and year. It includes information on the AHA hospid, the hospital's name and location, the year of the record, the source of the record, the AHA control and service codes, a code for the type of facility as listed on the POS, and up to three estimates of each hospital's bedsize (one from each source).

2.1.2 Problems Defining the Universe File

The universe file presented a few problems. Some of the hospitals on the file had never been acute-care facilities. Other hospitals did not have records for all the years 1980-1986. In addition, some of the records lacked hospids. Each of these problems was solved as follows.

2.1.2.1 Cleaning The File of Federal and Exempt Records

To clean the database of any records for federal hospitals, we moved hospitals with federal control codes (1,755 records) to a separate file. Nine U.S. public service hospital records were also added to this file, for a total of 1,764 records.

Non-acute-care hospital records were placed in one of two files, depending on the number of years of data on file. An exempt facility file, including any hospitals with a full six years of data that did not fit our acute-care definition, was created. These non-acute-care records included records for nursing homes and chemical dependency, substance abuse, long-term care, or psychiatric units. The second file included sequences of records for any non-acute-care hospitals included in the original file that did not have a full six years of data.

When there were more than six years of records for a hospital, the hospitals were contacted by telephone to find the reasons for the redundancies. In the majority of cases the excess records represented exempt

units of acute-care facilities. These records were added to the appropriate exempt file and deleted from the universe file.

2.1.2.2 No Hospid

There were 2,662 records without AHA hospids. Each record was assigned a sequence number for identification. These records were manually matched by name, FIPS county code, and bedsize with records in the same state that had an identification code. We were also able to assign a few hospids from an internal HER file which listed hospitals by state and hospid. Some hospitals could not be matched because of name changes. These were resolved using two types of sources: the AHA guides (1978, 1982, 1984 and 1986) and the provider of service (POS) file from HCFA.

Through these methods, we were able to assign identification codes to 2,028 records that had been missing then. An additional five records were United States service hospitals and were placed on the federal file. The 629 records that still lacked hospids were given internal HER reference numbers.

To provide more information on the hospitals given HER reference numbers, we did extensive phone calling. Calls were made to state and local hospital associations, and to state licensure bodies. This helped us determine whether hospitals had opened or closed, merged, or changed in some other way that affected their identification.

Compiling a complete computer file of acute-care, general hospitals was only the first step in the construction of the analytic file. Equally important for any study of the industry's structure, was ensuring complete data for the 1980 through 1986 period. Some hospitals were missing important

information for a few items; others lacked records for one or more entire years. These problems were resolved using various sources of information.

Padding Records for Missing Years

Some hospitals had incomplete sequences for the last years of the 1980-1985 period. If the hospital was open in 1986 according to the AHA survey data for that year, we assumed it had also been open during the intervening years. We padded the missing records with information from the last available year on file.

Hospitals that were complete except for 1980, 1981, or 1982 were checked against the AHA guides to see if they had been open prior to 1980. If the 1978 AHA guide showed that they were in business, we padded any years that were missing with information from the first year we had on file. The hospitals that did not show up in the AHA guides for the years in question were checked against the POS file to find their effective date for Medicare coverage. When the effective date was prior to the period in question, we assumed the hospital had been open, and we padded the missing years with information from the first available year on the file.

To clarify the status of the remaining incomplete sequences, we called state licensure agencies and a few state and local hospital associations. In the rare event when we were unable to obtain any information through this method, we contacted the hospital directly. We flagged the records of all the hospitals that had opened, closed, or merged, in the 1980-1986 period.

Control and Service Codes

Though our universe file consisted of complete six year records, some lacked important information, such as the hospital's service and control code, because we had no AHA entry for that hospital. Therefore, we generated a list

of records lacking either of these codes. By referring to the AHA guides (1978, 1980, 1982, 1986), we were able to pad these records with the codes they were missing. When the AHA did not list the hospital in question, we called state and local hospital associations, and state licensure agencies to obtain the needed information.

2.1.3 Bedsize Variables

Another problem with the universe file was that some of the bedsize numbers for the hospitals were questionable. As previously mentioned, we had three sources of bed size information: POS, HCRIS, and the AHA. Unfortunately, the POS's definition of a bed differs from the definition used by the AHA and HCRIS. The POS bed numbers reflect licensed beds and HCRIS's and the AHA's bed numbers represent staffed beds. Therefore, we constructed two variables, one for licensed beds and one for staffed beds. Though we had more complete information for licensed beds, we gave staffed beds priority in terms of defining bedsize. The reason for this choice was that staffed beds are a much more accurate indicator of the true bedsize of hospitals. Only when a hospital record lacked both HCRIS and AHA bed information did we rely on the POS licensed bed numbers.

To check potential discrepancies in bed sizes for individual hospitals throughout the 1980-1986 period, we created two lists from the universe file. The first contained hospitals whose bedsize between any two years in the period had changed by 33 percent or by more than 25 beds. The second list contained any hospitals where the source had changed at least once, and the bedsize had increased or decreased.

For both lists the hospital bed numbers were compared to those listed in the AHA guides (1978,1982,1984,1986). If the fluctuations in bed numbers listed in the file paralleled fluctuations noted in the AHA, the bed numbers were left unchanged. If the bed number sequences listed on the file differed

greatly from the AHA bed number sequences, we made an assumption about which numbers were more accurate, or we phoned the state boards of licensure to clarify which numbers were more correct. In a few instances, the hospitals were found to be exempt throughout the period in question.

2.1.4 Hospital Units

As previously mentioned, we obtained data from three sources: HCFA, POS, and the AHA. All three sources report information for different segments of the health care industry, though some of their reporting overlaps. They all organize their reporting by designating numbers to the smallest entities they are concerned with. For instance, HCFA reports on acute-care Medicare certified units and designates a number for each unit. They include acute-care units within institutions such as prisons and schools. The POS, unlike HCFA, not only reports on acute-care entities, it reports on all acute-care and non-acute-care providers of service, from clinics to hospitals; each of these providers is given a POS number. Though the AHA also reports on both acute-care and non-acute-care facilities, in contrast to HCFA and the POS, the AHA only reports information on hospitals. They sometimes designate one number for a related group of hospitals. For instance, if an urban hospital has a satellite branch in a local suburb, the AHA may give the same number to both hospitals.

Unlike HCFA, we did not include acute-care units housed within an institution such as a prison, school or mental hospital within our database. We chose to omit this type of acute-care unit from our definition of an acute-care hospital because it does not provide acute-care services to the general public; care is only administered to institution inmates. Unlike the POS, we did not include clinics or non-acute-care facilities within our database. Similar to the AHA our database is made up solely of hospitals, though unlike the AHA we limit our reporting to acute-care hospitals. In

contrast to the AHA we tried to list each hospital individually, rather than reporting on groups of affiliated hospitals.

In defining a hospital unit we concentrated on units within acute-care hospitals. For this study we define hospital units as those units in an acute-care hospital that do not offer acute-care services. Unlike the parent acute-care hospital, the exempt units are not covered under PPS. These exempt units provide such services as: long-term care, alcohol and chemical dependency programs, psychiatric services etc. In cleaning our acute-care hospitals' bed information, we omitted exempt unit beds whenever possible. We used the American Hospital Association (AHA) Guides (1978-1986) as a basis for determining whether an acute-care hospital housed an exempt unit. The AHA noted nursing home, alcohol and chemical dependency rehabilitation, and psychiatric beds for its registered hospitals. Thus we were able to subtract these beds from the total to obtain the acute-care beds. For those hospitals not registered with the AHA, but included in the AHA Guides, no information was given on exempt units. Therefore we were unable to discern whether these hospitals housed exempt units and hence could not correct their beds.

2.1.5 Acute-Care

In this study we define acute-care as short-term care which includes general medical and surgical services or some other select specialty services. As defined by the American Hospital Association (AHA), short-term signifies that the "average length of stay for all patients is less than 30 days or over 50% of all patients are admitted to units where average length of stay is less than 30 days." Included within our definition of select specialty services are: obstetrics and gynecology; eye, ear, nose and throat; and orthopedic. Also, we included services defined by the AHA "as other specialties" (e.g., arthritis, proctology and geriatrics etc). Many hospitals defined as offering these other specialties also have general medical and surgical units.

Our definition of acute-care does not include specialties such as: psychiatric services, alcohol and chemical dependency services, tuberculosis and other respiratory disease services, rehabilitation services, childrens' services, mental retardation services, and chronic disease services. In addition, acute-care does not include general medical and surgical services available in institutions such as prisons, schools or facilities for the mentally retarded.

2.1.6 Measures of Industry Concentration

Our first step was to look at concentration within hospital markets. Industrial economists use a variety of measures to describe the degree of concentration in a market or industry. Some are performance-oriented; others focus on some aspect of industry structure. The first type is not appropriate for this study of hospitals. They either require information we cannot obtain, such as marginal costs of hospital products,* or they use net profits, a variable we will be trying to relate to industry structure and therefore a poor candidate to measure it.

Not all structural measures are appropriate for this project either. For example, the simple market concentration ratios for the leading four firms mask the different structures of the many hospital markets with no more than 4 hospitals.** Another common problem with the simple ratios is that they ignore inequalities among firms. Suppose one market has one hospital with 70 percent of the market and six other hospitals each with 5%. A second market has four hospitals each with about 21% market share and a fifth with 15%. Both markets will have the same 4-firm concentration ratio of 85% yet the competitive conditions may be very different.

A number of summary measures avoid this problem by combining information

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*For example, the Lerner Index is defined as M=(Price-Marginal Cost)/Price.

**148 of the MSAs covered by HCFAs 1984 wage survey had four or fewer hospitals reporting. This is somewhat of an overestimate for urban areas but does not include concentrated rural markets.

about the number of firms and their market shares. The most commonly used of these is the Herfindahl-Hirschman Index:

$$H = \sum_{i=1}^{N} S_i^2$$

where S_i is the market share of the i-th firm. The index reaches a maximum of 1.0 for a monopoly and rapidly approaches zero as the market shares decrease. The Herfindahl index weights large firms more heavily than small ones. This means that different values for small firms' market shares do not change the index greatly. We use the Herfindahl to measure the degree of market concentration in each hospital market area within the United States. Counties form the basis of hospital market areas. We define rural market areas as the county in which a hospital is located. In urban areas markets are defined by MSAs (Metropolitan Statistical Areas), which are made up of counties. As previously mentioned, our database is made up of hospital level information. Because counties form the basis of both the urban and rural hospital market areas, we matched the hospital level information on our universe file with county level data from the ARF (Area Resource File) to create a county level file. Counties that were designated urban or rural in 1983 retained this definition during the analytic period.

The first step in our analysis was to create Herfindahl indexes for bedsize and admissions for each market area. If we lacked admissions information for one or more rural or urban hospitals in a county or MSA, we were unable to calculate a Herfindahl for this county or MSA, and therefore the Herfindahl value was set to missing. We had bedsize information for all of our hospitals, so this problem never arose for the bedsize Herfindahls. After the indices were calculated, they were sorted by size and reviewed to establish the reasonableness of the figures and to examine them for any obvious breaks in the series. This review revealed that all of the indices were positive, between zero and one, and therefore appeared reasonable, and that there were no such breaks.

After viewing the admissions and bedsize Herfindahls, we decided that the bedsize Herfindahls were more accurate indicators of market share than the admissions Herfindahls. There are two reasons: First, while bedsize gives an indication of how much capacity is available to treat patients, and therefore of the hospitals' ability to compete for patients, admissions only relate to the number of patients actually dealt with during any given period. Second, the services provided by hospitals tend to be positively correlated with the size of the hospital, and not necessarily with the admissions in any one year.

The Herfindahls we created accurately described the concentration of urban and rural hospital markets with the exception of markets that contained systems that owned or managed more than one hospital in the area. Our database contains a hospital level variable that designates system status. This variable was aggregated to the county level so that Herfindahls adjusted for system status could be run. In the instance when more than one urban hospital in an MSA or rural hospital in a county were owned or managed by the same system, we treated this urban or rural group of hospitals as one entity. We then recalculated the Herfindahls with this adjustment, thereby creating Herfindahls for counties or MSAs that contained system hospitals. These system Herfindahls reflect the potential for hospitals to have coordinating strategies rather than competing with one another.

2.2 The PPS Analytic File

The file of merged Medicare cost reports and AHA survey data was obtained from Abt Associates, Inc., as part of HCFA contract No. 500-85-0015. Its construction involved a great deal of computer processing. For a complete description of data processing and structure of the file see 'PPS Core Data Base' by C. Joseph and R. Boheim.

2.2.1 Summary of HCRIS Data Processing

Tests for duplicate cost reports were conducted on all files. Duplicate reports had the same provider identification code, cost report beginning and end dates, and status. Cost report records identified as duplicates were manually reviewed to determine consistency of data, presence of key variables and worksheets, and general data availability. The record fulfilling the greater part of these criteria (i.e., the "best" record) was selected for each provider and the other was deleted from the file. In a few cases on the cost reports, it was impossible to choose a cost report according to the above criteria, and one of the duplicate reports was selected randomly. The TEFRA duplicates were found to have identical data.

Because the PPS master file contained multiple cost reports for the same provider and reporting dates, it was necessary to select the "best" of these multiple reports as indicated by the status code. A total of 2,138 reports having identical ID numbers and reporting dates but lesser status were deleted from the file (e.g., any "audited" report was selected over any "as submitted"). In addition, 163 cases with all data missing were deleted from the PPS1 file and 36 non-U.S. hospitals were deleted overall.

Edit checks on cost report begin-end dates were then conducted to determine and eliminate problem cases. Noted problems included missing or unreadable values, data outside of the fiscal years for the payment systems, and reports with overlapping dates on the longitudinal file. Cases with unreadable values were deleted. Where typographical errors were obvious, corrections were made to the dates. Otherwise, cases where assumptions on dates would have been ambiguous were deleted from the files. Other anomalies such as reports beginning or ending a few days outside of their fiscal year limits or overlapping with reports on other files were documented, but not corrected.

Missing values will be an important issue for analysts since HCFA

treated them differently on each of the three files. The TEFRA master file has all zero values coded as missing. The PPS1 file contains both missing values and true zeros.

Since in some years HCFA did not require the submission of all worksheets, tests for the completeness of cost reports were conducted using frequencies for the number of missing worksheets and for specific missing worksheets for all cases. Most of the worksheets on all the files were missing for less than 5 percent of the cases. Problem worksheets on H180 included A-1 (42.8% missing) and G (74.4% missing). The TEFRA worksheets missing for a large percent of the cases was F (84.1% missing). The missing PPS worksheets were A-8 (89.0% missing), A-8-2 (22.9% missing), D-8 (14.8% missing) and F (83.7% missing). Over 50% of the cases in PPS1 were missing two worksheets while over 70% of the TEFRA cases reported one missing worksheet. The majority of the remaining cases reported either one or three missing worksheets.

2.2.2 The Structure of the PPS Analytic File

The analytic file is defined at the hospital level for each period between the hospital's fiscal year covered by TEFRA regulations and that covered by the third year of PPS. Only nonwaivered states are included. Because the hospitals' fiscal years could vary in length, all cost report flow variables, such as discharges, outpatient visits, costs, revenues, etc., were calculated as monthly values averaged across the fiscal year. AHA annual survey data items were also converted to monthly averages (for flow variables such as expenses, admissions, etc.) and matched to each hospital's cost report data according to the dates of the respective reports. Where AHA survey data time periods did not match those of the cost reports, a weighted average of the AHA data items from the two surveys covering the cost report period were matched to the latter.

In addition to these two data sources, hospital-level data items from Medicare's Impact file and county-level data items from the Area Resource File were also merged to the analytic file. Where these items were time dependent, they were matched to the year in which the mid-date of the hospital's Medicare Cost Reports for a given pay system (such as TEFRA or PPS-2) occurred.

2.3 Biased Sample Analysis

For some of the multivariate regressions in this report, it was desirable to restrict them to the set of hospital's with data for all four time periods; TEFRA, and PPS-1 through PPS-3. Further, inclusion of PPS-3 data (for 1985-1986) was felt to be most desirable. The problem is that this reduces the number of hospitals in the PPS analytic file to 3,792 from the almost 4,600 hospitals with data in the TEFRA through PPS-2 time periods.

A biased sample analysis on the four-period file indicates that it underrepresents urban hospitals, particular urban teaching hospitals, compared to a three-period file. Proprietaray hospitals are also underrepresented as are those located in the Pacific, Mid-Atlantic, and South Atlantic Census division. For rural hospitals, the four-period file contains 83-87 percent of the hospitals in the three-period (4,600 hospital) file. The lowest percentage is for hospitals with 50-99 beds that reported four periods of data. For analyses restricted to rural hospitals, the 2,047 facilities appear to be fairly representative of those in the nonwaivered states, although for any given data item, the possibility of missing data will greatly affect this.

3.0 THE STRUCTURE OF THE ACUTE-CARE HOSPITAL INDUSTRY

This chapter describes various elements of hospital market structure and relates them to the concentration of the hospitals' market shares. The Herfindahl index (HI) is used to categorize this provider concentration. Many of the elements of structure discussed in Chapter 1.0 are addressed including the dispersion of the number of hospitals and the degree of concentration in rural and urban areas, the number of beds per capita in rural and urban areas, and the number of HMOs in each market category. This general description serves as backround for the analyses of section 4.

3.1 Distribution and Concentration of Hospital Markets

How many hospital markets are there? For this project, markets were defined as either a rural county containing at least one short-term, acute care facility or an entire metropolitan area as defined by the Executive Office of Management and Budget. Table 3-1 shows the distribution of these urban and rural hospitals in 1986 in both the nonwaivered and waivered states. Nearly 80 percent of the 2,310 rural counties in the nonwaivered states contain a hospital, while 93 percent (37/40) of the rural counties in the waivered states contain hospitals. In contrast, all of the MSAs (284 in nonwaivered states and 34 in the waivered) have hospitals.

3.1.1 Rural Hospital Markets

Of the 1,868 rural counties with hospitals in the nonwaivered states, 51 percent (950/1868) are in counties adjacent to an MSA. In contrast, 86 percent (32/37) of the counties with hospitals in the waivered states are adjacent to an MSA. This can be explained by the fact that the waivered states (MA, NJ, NY, MD) are almost entirely urban, and therefore, do not

TABLE 3-1

NUMBER AND SIZE OF RURAL* AND URBAN** MARKETS, NONWAIVERED AND WAIVERED STATES, 1985***

	NONWAIVERED		WAIVERED	
	Rural	Urban	Rural	Urban
Total Rural Counties/MSAs	2,310	284	40	34
Number of Rural Counties/MSAs with Hospitals	1868	284	37	34
Number of Rural Counties with Hospitals Adjacent to MSA	950		32	
Number of Rural Counties with Hospitals Not Adjacent to MSAs	918		5	
Average Number of Hospitals per County/per MSA (range)				
Highest	6	138	5	88
Top 1 percent	4	68	5	88
Top 5 percent	3	33	5	69
Top 10 percent	2	20	4	28
Top quarter	2	9	2	15
Median	1	5	1	7
Bottom quarter	1	3	1	4
Lowest	1	1	1	1
Mean	1.39	9.00	1.89	13.00
Mean of adjacent counties	1.47		2.00	
Mean of nonadjacent counties	1.31		1.20	
Hospital Beds Per Capita (range)				
Highest	30.6	17.3	8.5	7.8
Top 1 percent	12.3	10.7	8.5	7.8
Top 5 percent	8.8	7.1	7.0	5.8
Top 10 percent	7.1	6.4	6.1	5.1
Top quarter	5.3	5.4	4.6	4.6
Median	3.9	4.3	3.5	4.1
Bottom quarter	2.8	3.3	2.8	3.2
Lowest	0.1	0.9	1.8	2.1
Mean	4.4	4.5	3.8	4.0
Mean of adjacent counties	3.8		3.6	
Mean of nonadjacent counties	5.1		5.1	

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*1983 data

**In NJ, PA, MD, WV, MA, RI, DC, VA, and DE a total of six MSAs overlapped between the nonwaivered and waivered states, these overlapping MSAs are included in both our nonwaivered and waivered numbers.

***Not including Alaska and Hawaii.

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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contain many counties that are not adjacent to an MSA.

The dispersion of the average number of hospitals per rural county is displayed in the next section of the rural column. The range of percentiles in the rural areas of the nonwaivered states is from six hospitals to one. The value of one at the median shows that over half of the rural counties contain monopoly hospitals. One out of ten counties contain two hospitals, as denoted in the top ten percent and one out of twenty contain three hospitals in the top five percent. The existence of six or even four hospitals in a county (highest category and top one percent, respectively) is surprising, given their usually sparse population. However, some rural areas consist of large towns where the growing demand for health care require more than one hospital.

This population growth has caused some of these rural areas to become MSAs since 1983, the year for which our typology is fixed. Another explanation is suggested by the rural county with six hospitals, Humboldt county, California. The town of Eureka in Humboldt has nearly 25,000 people with several smaller towns around it. The counties with five hospitals are either adjacent to an MSA or have several small towns like Humboldt, each with its own hospital. At the other extreme, many of the counties with one hospital are not adjacent to MSAs and have low population density (e.g., those located in rural Wyoming).

There has been considerable discussion within the hospital industry regarding differences between rural counties adjacent to MSAs and those that are not. Adjacent counties are generally close to MSAs where numerous hospitals exist and therefore the adjacent rural hospitals have to compete with urban facilities. Counties that are not adjacent to MSAs do not face the same degree of competition.

Rural beds per capita range from 0.1 to 30.5. The median rural county in the nonwaivered states has 3.9 beds for every one thousand people. One out of four hospitals have five beds per one thousand and one out of ten has seven beds per thousand. The county with 30.6 beds per 1,000 is Montour county in

Pennsylvania, which is immediately adjacent to two MSAs. There are also several other MSAs near Montour, making the surrounding area highly urban. The value of 12.3 beds per thousand pertains to Clay county, Georgia, which is not adjacent to an MSA, however. At the bottom of the scale, is Greer county (nonadjacent), Oklahoma.

The rural counties in the waivered states display somewhat the same range in the number of hospitals as the nonwaivered states do. Most of these counties are adjacent to an MSA, which is to be expected because most of the waivered states are heavily urbanized. One of the counties with five hospitals is Wicomico in Maryland, a nonadjacent county. However, Wicomico has a population over 60,000 and is close to a number of MSAs. Therefore, the pattern of dispersion of the number of hospitals between the waivered and nonwaivered states is not very different.

The range of hospital beds per capita for the rural hospitals in the waivered states is much smaller than that of the nonwaivered states. This may be because these hospitals are more similar in size than in the nonwaivered states or because regulations are stricter (as in New York State). The overall mean of 1.89 is larger than the overall mean of 1.39 in the nonwaivered states. However, the magnitude of the overall mean of beds per capita is reversed. That is, the average waivered state county has a greater number of hospitals, but may not necessarily have a correspondingly larger number of beds. Because of this, the county with the greatest number of hospitals does not correspond to the county with the largest bedsize. The median value of one means that approximately half the counties have monopoly hospitals, similar to the nonwaivered states. One out of four waivered counties has two hospitals. The mean of the adjacent counties in waivered states is larger than that for the nonadjacent counties. This gap is wider than that of the non-waivered states, because the waivered states are more urbanized.

3.1.2 Urban Markets

The average number of hospitals in the urban areas of nonwaivered states displays a very large range, compared to the rural areas. The MSA with 138 hospitals is Los Angeles. Philadelphia has the next largest number (68). The drop from 138 to 68 is probably due to the sizes and population densities of the two MSAs. Los Angeles, for example, has nearly three times the population as Philadelphia. However, the population density of the former is much smaller because Los Angeles contains 4,070 square miles of land whereas Philadelphia has 136 square miles. At the lower end of the range (one hospital in the market) is Wausau, Wisconsin. Wausau has a population of nearly 32,500.

The beds per capita for counties in the nonwaivered states display a much smaller range than their rural counterparts. The range is 16.4 beds per every thousand population. The median value of 4.3 means that in over half of the MSAs hospitals provide at least four beds for every thousand people. The high value of 17.3 is Rockville, Maryland and low of 0.9, Bloomington, IN. The mean value of 4.5 means that on average an urban county provides approximately one bed for every two thousand people. The MSAs with hospitals that have the higher beds per capita ratio are not necessarily the large MSAs such as Los Angeles, however.

The waivered states have more hospitals per MSA, on average, than the nonwaivered states (13 versus 9). The median shows that at least half of the waivered counties contain seven hospitals. One out of four waivered MSAs contain fifteen hospitals and one out of ten contain twenty-eight hospitals. However, at least one out of four MSAs contain no more than four hospitals.

The beds per capita also display a smaller range than that in the nonwaivered states. Half the waivered MSAs have 4.1 beds to every one thousand people. One out of ten contains 5.1 beds per thousand. Within the bottom quarter, however, one out of every four MSAs have 3.2 beds per thousand. The mean value, however, is just below the mean of the nonwaivered

states (4.0 versus 4.5). This is contrary to the larger mean number of hospitals in the waivered state MSAs. Therefore, there is a hospital size difference. The nonwaivered states contain the larger hospitals in both the urban and rural markets.

3.2 Concentration of Markets

The number of rival firms in a market is not the best measure of the presence or absence of market power because one of the rivals may have a dominant market share and therefore have some power over the terms of trade in the market. The Herfindahl Index (defined in Chapter 2) is employed here as a measure of seller concentration. Two index values were calculated. One treated each hospital as an independent entity, ignoring affiliations in multihospital systems (except when the AHA or Medicare combined several hospitals in one record). The other index was calculated combining affiliated hospitals in the same market (MSA or rural county). Thus if two rural hospitals of equal size were owned by the same entity and were the only acute-care facilities in a given county, the Index would be 0.5 ignoring the affiliation and 1.0 taking it into account. The question is whether multihospital affiliation concentrates hospital markets significantly.

3.2.1 Concentration of Market Shares Across Hospitals in Markets

The primary policy concerns over market concentration are 1) whether higher average costs are indeed associated with less market concentration, *ceteris paribus* and 2) whether there was a more marked change in relative costs following the inception of PPS. This section describes the amount of concentration in hospital markets during the 1980s. Its relationship to costs is the topic of section 4.1

Table 3-2 presents Herfindahl Index values for urban and rural markets. The value of 1 corresponds to a hospital monopoly while a value close to 0

TABLE 3-2

FREQUENCY DISTRIBUTION OF HERFINDAHL VALUES FOR URBAN AND RURAL MARKETS, NONWAIVERED AND WAIVERED STATES, PRE/POST PPS

	NONWAIVERED					
	URBAN			RURAL		
Distribution of Market Concentration	1980	1983	1986	1980	1983	1986
Highest	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Top Quarter	.4481	.4570	.4455	1.0000	1.0000	1.0000
Median	.2859	.2898	.2946	1.0000	1.0000	1.0000
Bottom Quarter	.1651	.1665	.1654	.5863	.5983	.6194
Lowest	.0125	.0127	.0134	.2024	.2019	.2029
Means:						
All Counties	.3283	.3294	.3310	.8495	.8545	.8609
Adjacent Counties				.8236	.8305	.8366
Nonadjacent Counties				.8763	.8794	.8861

	WAIVERED					
	URBAN			RURAL		
Distribution of Market Concentration	1980	1983	1986	1980	1983	1986
Highest	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Top Quarter	.3223	.3365	.3643	1.0000	1.0000	1.0000
Median	.1586	.1685	.1747	1.0000	1.0000	1.0000
Bottom Quarter	.0880	.0882	.0922	.4595	.4583	.5019
Lowest	.0162	.0173	.0175	.1756	.2210	.2294
Means:						
All Counties	.2167	.2257	.2294	.7403	.7385	.7656
Adjacent Counties				.7182	.7163	.7446
Nonadjacent Counties				.8812	.8812	.9004

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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means that the concentration of hospitals is very low. Index values for the urban areas in 1980 in the nonwaivered states range from 1.0 to 0.0125. This range does not change much by 1986. The median value of 0.29 is consonant with three to four equally sized hospitals per MSA. Table 3-1 showed that the median number was five. Therefore the five must be unequal in size, to give the Index value of .29, with the beds concentrated somewhat in only a few of the five facilities. Similarly, the mean Herfindahl value of .3283 translates into approximately three hospitals in an MSA. However, the mean number of hospitals per urban market is nine (Table 3-1). These numbers are consistent with a high degree of concentration in most urban markets but a very large number of hospitals in the least concentrated ones.

In comparison, the average rural hospital is a monopoly. The median Herfindahl Index for rural markets in all three years was 1.0. Therefore, more than half of the rural markets are county monopolies. In fact, even the lowest category of rural counties shows a value (.2024 in 1980) indicating a high level of concentration which is in keeping with the fact that the most hospitals in any rural county is six (Table 3-1).

Table 3-2 presents the range of Herfindahls for three years to capture any differences in concentration between pre- and post-PPS periods. The mean values for both urban and rural hospitals increase slightly between 1980 and 1986, which means that hospitals in urban and rural markets are becoming slightly more concentrated. However, no quartile changes by a percentage large enough to change the characterization of the market concentration. That is, no quartile changes by as much as 0.05 (e.g., from that with Herfindahls of 0.01-.05 to 0.05-0.1

Table 3-2 also presents mean Index values for rural counties according to their propinquity to urban areas. In each of the years shown, hospitals in rural counties adjacent to MSAs were only slightly less concentrated, on average, than those in counties not bordering on an MSA. For the former, the index values increased from 0.8236 in 1980 to 0.8366 in 1986. These values suggest the monopolistic nature of almost all rural markets. The Index values

for nonadjacent hospitals are only slightly higher - ranging from 0.8763 in 1980 to 0.8861 six years later.

In the waivered states, the mean values for both urban and rural markets are lower. The mean values for the urban markets suggest that they are larger and therefore much less concentrated on average, than rural markets, which are monopolistic. The trend of increasing concentration from 1980 to 1986 is present in these states as well, although there it is not constant: the 1983 mean value of the rural hospitals declined between 1980 and 1983 before increasing post-PPS. This is attributable to changes in the rural counties adjacent to MSAs (which dominate in these highly urbanized states). Overall, the increased concentration was not significant, however, in that it did not change the characterization of any urban or rural market percentile. That is, markets that had Index values of 0.18 to 0.3 in 1980 remained in that range throughout the period being examined.

3.2.2 Market Concentration Due To Multihospital Systems

In the past few years, there has been an increasing growth in multihospital systems (MHSs). There were 302 MHSs in the country in 1986 representing 2,255 of 5,649 acute-care hospitals. Forty-two percent of these were in rural markets (Hendricks, et al., 1988). Integration into systems leads to more seller concentration and more potential market control. If the two hospitals in a duopoly belong to the same system, for example, they are able to coordinate their strategies and hold monopoly power. Therefore, the Antitrust Division of the Department of Justice examines mergers that would potentially expand one system's power in an individual market and contests some of them. Despite this, in 113 MSAs, two or more hospitals belong to the same MHS and Herfindahl Indexes calculated using the combined beds of these integrated hospitals as one market share are higher in value (show more concentration) than those in which each hospital is weighted as an individual firm.

Table 3-3 displays the dispersion of market concentration of the system (adjusted) and freestanding (unadjusted) hospital units in urban and rural markets in 1986. The median value of 0.3083 translates to nearly three equally sized hospitals in an MSA for nearly half of the MSAs compared to 0.2946 before the MHS adjustment. The bottom quarter of MSAs have an adjusted concentration index of 0.1830 compared to 0.1654, unadjusted. The difference that the adjustment makes for the top quarter is greater (from 0.4455 to .50). Thus, while system integration is increasing seller concentration within markets, it is not enough to change the characterization of the urban market structure.

In rural markets concentration due to system hospitals in the same market is even less important. The majority of hospitals in the rural areas are in highly concentrated markets, as indicated by both the mean and median values. The median Index values of 1.0 for both the system and freestanding hospitals of indicates that monopolies dominate in the rural markets regardless of system affiliation. Indeed, the Index values adjusted for system affiliated hospitals changed in only 26 out of 1868 rural counties.

The waivered states are less concentrated on average than the nonwaivered for both system and independent hospitals. The median value of 0.1072 for the system hospitals in the waivered urban areas suggests that nearly half of the MSAs contain the equivalent of five or six equally sized hospitals. One out of four MSAs, the top quarter, has over three hospitals. The range of values for the unadjusted Index shows the same results. That is, urban markets in the waivered states are not as concentrated as the urban markets in the nonwaivered states. The mean values of the urban markets in the waivered states indicate three to four equally sized hospitals in an MSA.

The rural markets in the waivered states display the same range of market concentration for both the system and freestanding hospitals. This may be due to the fact that waivered states are highly urbanized, with very few rural areas. The value of one at the median demonstrates that over half of rural counties are monopolies. Even at the bottom quarter, the value of

TABLE 3-3

FREQUENCY DISTRIBUTION OF HERFINDAHL VALUES FOR SYSTEM AND INDEPENDENT HOSPITALS, 1986

	NONWAIVERED			
	ADJUSTED		UNADJUSTED	
Distribution of Market Concentration	Urban	Rural	Urban	Rural
Highest	1.0000	1.0000	1.0000	1.0000
Top Quarter	.5000	1.0000	.4455	1.0000
Median	.3083	1.0000	.2946	1.0000
Bottom Quarter	.1830	.6352	.1654	.6194
Lowest	.0212	.2050	.0134	.2029
Mean	.3489	.8649	.3310	.8609
Mean of Adjacent Counties		.8424		.8366
Mean of Nonadjacent Counties		.8883		.8861

	WAIVERED			
	ADJUSTED		UNADJUSTED	
Distribution of Market Concentration	Urban	Rural	Urban	Rural
Highest	1.0000	1.0000	1.0000	1.0000
Top Quarter	.3643	1.0000	.3643	1.0000
Median	.1887	1.0000	.1747	1.0000
Bottom Quarter	.1072	.5019	.0922	.5019
Lowest	.0212	.2294	.0175	.2294
Mean	.2390	.7656	.2294	.7656
Mean of Adjacent Counties		.7446		.7446
Mean of Nonadjacent Counties		.9004		.9004

Source: Merged AHA surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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0.5019 confirms highly concentrated markets. Similarly, the mean value of 0.7656 shows that on average rural markets are very concentrated with perhaps two hospitals, one relatively large compared to its rivals.

The data in this table suggests that system affiliation does not greatly affect market concentration. The range of values do not differ significantly between independent and system hospitals. The greatest difference occurs between the markets of the nonwaivered and waivered states.

3.3 Distribution and Concentration of HMOs within Hospital Markets

The conceptual model for the analyses in this study postulates that HMOs will tend to be found in the most costly hospital markets but that in markets where they represent a large number of potential patients they will effectively lower hospital costs. The mechanism for lowering costs may be the lower per capita utilization for many HMO memberships or it may be due to greater market power on the part of the HMOs in contracting with providers for lower charges and more cost containment. This section describes the distribution and growth of HMOs. Their relationship to relative hospital costs is analyzed in Chapter 4.

Table 3-4 shows the distribution of HMOs in urban and rural markets, both pre- and post-PPS. In non-waivered states, less than one quarter of the urban and less than one percent of the rural areas had any HMOs either before or after the advent of PPS. HMOs are not only far more prevalent in urban areas than in rural ones, the spread of HMOs between 1980 and 1984 was largely in metropolitan areas that already contained several such alternative health plans. This is perhaps not surprising because one would expect HMOs to locate in heavily populated areas where business prospects are better.

In the non-waivered states, MSAs with high concentrations of HMOs averaged 11 to 13 HMOs per MSA from 1980 to 1984, whereas a single HMO during this period would be considered a heavy rural concentration. Whereas in 1980 one in twenty MSAs had at least two HMOs, by 1984 they had at least three.

TABLE 3-4

DISTRIBUTION OF NUMBER OF HMOs IN URBAN AND RURAL AREAS, PRE/POST PPS

NONWAIVERED

Range	1980 Urban MSAs	1980 Rural Counties	1983 Urban MSAs	1983 Rural Counties	1984 Urban MSAs	1984 Rural Counties
Highest	11	2	9	1	13	1
top 1 percent	6	0	8	0	8	0
top 5 percent	2	0	3	0	3	0
top 10 percent	2	0	2	0	2	0
top quarter	0	0	0	0	0	0
median	0	0	0	0	0	0

WAIVERED

Range	1980 Urban MSAs	1980 Rural Counties	1983 Urban MSAs	1983 Rural Counties	1984 Urban MSAs	1984 Rural Counties
Highest	3	0	2	0	3	1
top 1 percent	3	0	2	0	3	1
top 5 percent	2	0	2	0	2	a
top 10 percent	1	0	2	0	2	0
top quarter	1	0	1	0	1	0
median	0	0	0	0	0	0

[a] The average was less than 0.5

Source: Merged AHA annual surveys, Medicare Provider of Serivce File and Cost Reports, Area Resource File.

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In contrast to the range of HMO concentration in urban areas in non-waivered states, less than one percent of rural areas (fewer than 19 rural counties) had any HMOs, and in this category the concentration of HMOs decreased from two HMOs pre-PPS to only one after 1983. The urban and rural HMO concentrations in nonwaivered states suggest that the market for HMOs in urban areas became more attractive post-PPS, whereas the market for HMOs in rural areas became less so.

The concentration of HMOs in waivered states differs significantly from that in nonwaivered states. While over half of the waivered MSAs are without an HMO, these providers are present in at least one quarter of the urban areas while in the non-waivered states the proportion is smaller. On the other hand, urban areas with the highest concentration of HMOs averaged between two and three HMOs in the pre- and post-PPS periods, compared to a high of 11 HMOs in urban areas in non-waivered states.

Table 3-5 presents the distribution of MSAs, pre- and post-PPS, according to the degree of market concentration and the number of HMOs. (Rural markets and markets in waivered states are not described here because of their small numbers of HMOs.) In 1980, over 80 percent (231 of 284) of all non-waivered MSAs lacked HMOs. This proportion decreased to 70 percent (200) by 1984. Less than 10 percent of MSAs, pre- and post-PPS, had one HMO and about five percent had two. In 1980, less than five percent of MSAs had three or more HMOs, but by 1984, this had grown to 7 percent. The increase in HMOs from the pre-PPS to the post-PPS period occurs disproportionately in areas that already had three or more HMOs, however, as we have already seen in Table 3-4.

In both 1980 and 1984, MSAs with HMOs are more likely to be the least concentrated markets. For example, in 1980, 52 percent of the MSAs lacking HMOs were in the most highly concentrated hospital markets, whereas only 32 percent of the MSAs with one HMO, 13 percent of those with two HMOs, and no MSAs with three or more HMOs fell into the most concentrated Herfindahl category. This picture changed only slightly by 1984 with 59 percent of the

TABLE 3-5

PERCENT OF ALL MSAs BY DEGREE MARKET CONCENTRATED WITHIN CATEGORIES OF HMO PENETRATION, 1980, 1984.*

	HMO PENETRATION							
	1980				1984			
	No HMO	One HMO	Two HMOs	Three or More HMOs	No HMO	One HMO	Two HMOs	Three or More HMOs
Number of MSAs	**231**	**25**	**16**	**12**	**200**	**36**	**17**	**31**
Degree of Market Concentration**	100%	100%	100%	100%	100%	100%	100%	100%
Least Concentrated (1)	3%	12%	19%	58%	0%	5%	0%	48%
2	4	12	13	8	1	22	35	29
3	14	20	31	25	14	22	12	16
4	26	24	25	8	26	19	47	3
Most Concentrated (5)	52	32	13	0	59	31	6	3

*Nonwaivered states only.
**Categories defined by Herfindahl Index.

Least concentrated	(1)	HI = 0.00 - 0.05
	(2)	HI = 0.05 - 0.1
	(3)	HI = 0.01 - 0.18
	(4)	HI = 0.18 - 0.30
Most concentrated	(5)	HI = 0.30 - 1.0

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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MSAs with no HMOs located in the most monopolistic markets, along with 35 percent of MSAs with one HMO, and six percent of MSAs with two HMOs. In contrast, post-PPS, five percent of MSAs with three or more HMOs are located in monopolistic markets. The relatively small proportion of MSAs with HMOs and hospital monopolies is consistent with relatively low population and therefore less potential HMO business.

Table 3-5 confirms that HMOs are in urban markets of all sizes. Where there are fewer hospitals (concentration categories 4 and 5) there tend to be at most one or two HMOs, presumably because these markets do not have large populations. Larger hospital markets are associated with more HMOs. Over three quarters of the MSAs with three or more HMOs have concentration indexes less than 0.18, indicating at least six, and almost always more, hospitals.

Buyer concentration confers market power if a significant number of buyers coordinate their demands in the markets. For HMOs, the number of plans in a market does not confer market power but large enrollments of members may. Table 3-6 demonstrates that the concentration of urban markets is correlated with the size of the HMO membership. Both before and after the advent of PPS, the least concentrated urban markets (containing both the most hospitals and HMOs) tend to have the largest HMO enrollments. This is demonstrated by the fact that in the analytical file of about 1900 urban hospitals with data for their TEFRA fiscal years, 597 (the largest cell), were in the MSAs with the largest numbers of HMO enrollees while 179 were in the most concentrated markets with no HMOs at all. Changes between the TEFRA and PPS-2 analytical years are due in part to changes in the number of hospitals in the sample, but show that the basic relationship of market concentration and HMO stayed the same.

3.4 Product Differentiation

Firms differentiate their products to gain market share. Product differentiation can be along many dimensions including firm image and

TABLE 3-6

NUMBER OF URBAN HOSPITALS IN ANALYTICAL FILE BY DEGREE MARKET CONCENTRATED WITHIN CATEGORIES OF HMO MEMBERSHIP*

		HMO MEMBERSHIP***									
		TEFRA					PPS-2				
Degree of Market Concentration**		1	2	3	4	5	1	2	3	4	5
Least Concentrated	1	0	10	29	57	597	0	2	25	11	562
	2	23	16	60	41	173	1	21	67	47	255
	3	113	84	82	54	30	29	94	98	61	60
	4	131	98	86	18	23	88	76	93	24	33
Most Concentrated	5	179	84	29	4	3	124	77	87	6	8

*Nonwaivered States Only

**Categories defined by Herfindahl Index

***HMO Membership Categories:

(1) = 0 Members
(2) = 0 < members ≤ 5000
(3) = 5000 < members ≤ 25,000
(4) = 25,000 < members ≤ 50,000
(5) = members > 50,000

Least Concentrated (1) HI = 0.00 - 0.05
(2) HI = 0.05 - 0.1
(3) HI = 0.01 - 0.18
(4) HI = 0.18 - 0.30
Most Concentrated (5) HI = 0.30 - 1.0

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

EXK8861189

location, product quality, etc. The hospital industry is no different. Hospitals are differentiated by their locations, religious affiliation (or lack thereof), decor, quality of meals, number of staff involved in patient cure, quality of both medical and nonmedical staffs, and by many other characteristics. Hospitals must spend money to follow one of these competitive strategies. The premise is that the more they have to compete, the more costly it will be and this will be detected in average cost measures.

One primary strategy for this type of non-price competition is the acquisition of highly technical equipment. In the hospital industry, the addition of new services is one form of gaining market share. It is also a necessary strategy to preserve market shares where rivals are adding new services and facilities. Indeed, Luft et al., (1986) found that acquisition patterns across markets were competitive rather than complementary. The greater the percentage of neighboring hospitals with a designated special service, the more likely hospitals were to offer that service themselves. Therefore, the offering of specialized services tended not to be regionalized or limited to a few providers within an area.

This finding might suggest that markets with more rivals would have not only more of them offering a given service but also a greater proportion of them offering the service. On the other hand, for many services it may become the standard that at least one hospital in each metropolitan area must have the service. Therefore, the smaller MSAs would tend to have the service in a larger proportion of facilities because of the smaller hospital base. For example, if at least one hospital in every MSA offered the service, monopolies would inconsistently have the highest measure (1.00).

Table 3-7 presents the mean proportions of hospitals within MSAs of different degrees of concentration with each of five special facilities in 1982 and 1986. In general, it is weak evidence, at best, that the offering of these facilities is related to the seller concentration within these markets. The proportions drop somewhat as one moves from the least concentrated markets to those that average only six hospitals before rising for the most concentrated markets which include the few urban monopolies and oligopolies.

TABLE 3-7

MEAN PROPORTION OF HOSPITALS WITH INDICATED FACILITY BY DEGREE OF HOSPITAL CONCENTRATION IN MSAs, PRE/POST PPS*

Degree of Seller Concentration**		Number of MSAs	Mean Hospitals	Diagnostic Radio - isotope		Mega Volt Rad Ther		Ultra Sound		N M R		CT SCAN	
				1982	1986	1982	1986	1982	1986	1982	1986	1982	1986
Least Concentrated	(1)	18	49	.768	.745	.231	.238	.827	.843	.007	.101	.500	.713
	(2)	22	23	.750	.772	.271	.257	.820	.876	.002	.132	.525	.755
	(3)	43	11	.755	.779	.244	.254	.821	.882	.000	.116	.482	.752
	(4)	68	6	.710	.731	.201	.224	.773	.860	.000	.087	.406	.693
Most Concentrated	(5)	135	3	.798	.800	.346	.348	.850	.913	.002	.071	.576	.776

*Non-waivered states only; excluding Alaska and Hawaii

**Categories defined by Herfindahl Index.

Least concentrated (1) HI = 0.00 - 0.05
(2) HI = 0.05 - 0.1
(3) HI = 0.01 - 0.18
(4) HI = 0.18 - 0.30
Most concentrated (5) HI = 0.30 - 1.0

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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This pattern is strongest for NMR and CT scans. Magnetic resonance imaging was extremely new in hospitals in 1982 but by 1986 ten percent of the hospitals in the 18 largest markets (with an average of 49 hospitals per market) had one. Thirteen and twelve percent of the acute-care institutions in the next most concentrated areas also had one and the differences in these means are not statistically significant. For the most concentrated urban categories (by far the majority of MSAs) the proportions were lower. While also not statistically significant due to the variation across areas, many of which had no NMR in 1986, the pattern is suggestive.

A similar weak pattern is suggested for CT scans. However, for diagnostic radioisotopes and ultrasound, virtually all urban hospitals claimed to have them in both 1982 and 1986, regardless of the size of the market. A quarter of hospitals had megavoltage radiation therapy as well except for the smallest MSAs where one in three offered it.

This table underscores the difficulty in attempting to make these market distinctions with the AHA survey information which indicates only whether a hospital has the service. The size, cost, utilization, and other information that are necessary to evaluate differences is not available. Therefore, there may indeed be differences in technological costs that are related to the differences in non-price competition induced by market structure. However, using these services does not appear to be fruitful.

Table 3-8 presents mean proportions of hospitals with each of four specialized services in 1982 and 1986. Open heart surgery is reportedly a highly prestigious service and many hospitals are trying to expand into that area despite the fact that almost a quarter of hospitals in MSAs of every degree of concentration offer this service. The proportions expanded between 1982 and 1986 indicating that in most MSAs, one or more hospitals added this service around the time PPS was instigated.

The ability to perform organ transplants is a more esoteric service and did not expand considerably between 1982 and 1986 in the sense that few hospitals added the service at this time. A somewhat higher proportion of hospitals in large MSAs offer it, but this is not a significant difference.

As with the technological facilities described in Table 3-7, the statistics concerning hospitals' offerings of hemodialysis or organ transplants conceal important differences in the sizes, utilization, quality, and costs of these services across hospital markets. In terms of mere counts of hospitals offering a given service, this measure offers little promise of explaining higher average costs at this time. Therefore , for this study, a different approach was taken.

The conceptual model suggests that in markets with a greater degree of product differentiation, non-price rivalry should be greater. Administrators speak in interviews about the fact that adding services requiring complicated technology leads to the designation of a flagship hospital. For this study, therefore, it was hypothesized that hospitals in markets with more flagship hospitals would have strategies of greater non-price competition than hospitals with less competition at the highest end (technologically speaking) of the market, holding constant the higher costs of the flagship hospitals themselves. Hospitals that offer one of the following services were designated flagships: neonatal care, trauma centers, organ and kidney transplants and burn care. Open heart surgery was not used as a designator because a quarter of hospitals claimed to offer it, reducing its usefulness in indicating which hospitals are flagships.

Table 3-9 displays the number of MSAs containing various numbers of flagship hospitals. The percent of the total hospitals that are flagships is also presented to control for market size. The values are the numbers of MSAs in each cell. Therefore, the value of twenty in the least concentrated markets, under the heading 7+, indicates that there are twenty urban markets in the total country with seven or more flagship hospitals. This is the total number of MSAs of this size. Eleven MSAs in the second concentration category have three to six flagships whereas twelve MSAs of this size have seven or more flagships. The majority of MSAs in the next category of concentration have no more than six flagship hospitals. Most MSAs in the most concentrated markets have one or two flagship hospitals. Markets with no premier hospital are more concentrated with fewer facilities.

TABLE 3-8

MEAN PROPORTION OF HOSPITALS WITH INDICATED SERVICE BY DEGREE OF HOSPITAL CONCENTRATION IN MSAs, PRE/POST PPS*

Degree of Seller Concentration**		Number of MSAs	Mean Hospitals	Open Heart Surgery 1982	Open Heart Surgery 1986	Organ Transplants 1982	Organ Transplants 1986	Cardiac Catheter. 1982	Cardiac Catheter. 1986	Hemo - dialysis 1982	Hemo - dialysis 1986
Least Concentrated	(1)	18	49	.174	.200	.090	.085	.266	.287	.368	.451
	(2)	22	23	.221	.251	.094	.102	.274	.341	.357	.451
	(3)	43	11	.216	.265	.079	.101	.296	.381	.342	.400
	(4)	68	6	.187	.231	.056	.068	.252	.308	.291	.334
Most Concentrated	(5)	135	3	.224	.282	.062	.062	.290	.395	.436	.451

*Nonwaivered states only; excluding Alaska and Hawaii.
**Categories defined by Herfindahl Index.

st concentrated	(1)	HI = 0.00 - 0.05
	(2)	HI = 0.05 - 0.1
	(3)	HI = 0.01 - 0.18
	(4)	HI = 0.18 - 0.30
Most concentrated	(5)	HI = 0.30 - 1.0

Source: Merged AHA annual surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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TABLE 3-9

NUMBER OF MSAS BY THE NUMBER AND PERCENT OF FLAGSHIP HOSPITALS IN URBAN MARKETS WITHIN HERFINDAHL CATEGORIES, 1986

Degree of Market Concentration*		NUMBER OF FLAGSHIP HOSPITALS IN URBAN MARKETS					PERCENT OF FLAGSHIP HOSPITALS TO TOTAL HOSPITALS					
		0	1-2	3-6	7+	Total	0-0.10	0.10-0.20	.20-.40	0.40-0.60	0.60+	Total
Least Concentrated	(1)	0	0	0	20	20	0	1	16	3	0	20
	(2)	0	1	11	12	24	1	0	22	1	0	24
	(3)	1	12	32	5	50	4	8	20	13	5	50
	(4)	5	38	28	0	71	6	13	27	23	2	71
Most Concentrated	(5)	17	118	12	0	147	17	7	36	40	47	147
TOTAL		23	169	83	37	312	28	29	121	80	54	312

*Categories defined by Herfindahl Index.

Least concentrated (1) HI = 0.00 - 0.05
(2) HI = 0.05 - 0.10
(3) HI = 0.01 - 0.18
(4) HI = 0.18 - 0.30
Most concentrated (5) HI = 0.30 - 1.00

Source: Merged AHA Annual Surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

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In summary, the number of flagship hospitals is closely related to the total number in a market. Therefore, markets with seven or more flagship hospitals are the least concentrated whereas those with fewer flagship hospitals are the most concentrated. Therefore, to evaluate the prevalence of hospitals with one of these four services, controlling for the size of the hospital market, the percentage of all hospitals in a market that are flagships is important.

The first column in the right section of Table 3-9 represents the number of MSAs in markets in which zero to ten percent of the hospitals are flagships. In this column, seventeen MSAs are characterized as most concentrated. No large market is without a flagship hospital. The next column describes the number of MSAs in urban markets where the hospital make-up is ten to twenty percent flagships. Most of the MSAs in this column are again in the most concentrated markets. The preponderance of MSAs in the two categories of least concentrated markets have 20 to 40 percent of thier hospitals being flagships an even finer breakdown (if space allowed) would show that most of these are in the 20 to 30 percent range. Because we have already seen in Table 3-8 that only about ten percent of these hospitals have organ transplants services, this much larger percentage of flagships suggests that these four services are more complementary than competitive. That is, there may be less overlap in the provision of these services than for almost all of those described in Tables 3-7 and 3-8 above.

3.5 Concentration Due to Mergers

Horizontal integration is the merging of two or more firms in the same market. In the hospital industry, there were a number of mergers pre- and post-PPS. Table 3-10 lists the number of mergers within market concentration categories. Prior to PPS, (1981-83) urban and rural markets had the same number of mergers, four. The number of mergers is dispersed across concentration categories in both the urban and rural markets.

The number of mergers increased in both urban and rural markets after PPS (1984-86). Mergers are split between the least concentrated market, and

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TABLE 3-10

NUMBER OF MERGERS WITHIN HERFINDAHL CATEGORIES, PRE/POST PPS*

Degree of Market Concentration**		PRE-PPS		POST-PPS	
		Urban	Rural	Urban	Rural
Least Concentrated	(1)	2	N/A	7	N/A
	(2)	0	1	0	1
	(3)	1	1	1	2
	(4)	0	1	7	9
Most Concentrated	(5)	1	1	1	0
TOTAL		4	4	16	12

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*Nonwaivered states only, 1981-1986

**Categories defined by Herfindahl Index.

		Urban	Rural
Least concentrated	(1)	HI = 0.00 - 0.05	N/A
	(2)	HI = 0.05 - 0.10	.18-.30
	(3)	HI = 0.01 - 0.18	.30-.50
	(4)	HI = 0.18 - 0.30	.50-.89
Most concentrated	(5)	HI = 0.30 - 1.00	1.00

Source: Merged AHA Annual Surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

EXK851121988

the more oligopolistic market (category four) in the urban areas. This is a threefold increase in the least concentrated market category post-PPS. The total number of urban mergers increased four fold from four to sixteen, post-PPS. The majority of mergers in the rural areas occur in duopoly markets. The total number of mergers increased threefold, post-PPS.

The numbers of both urban and rural mergers in the same MSA or rural county, as reported by the American Hospital Association, increased in a major way after 1983. A seperate report (Hendricks, et al., 1988) in this series examines these facilities with available utilization and financial data. the mergers had only a small effect on market concentration during this period, however, and were judged to be of minor analytic importance at this time.

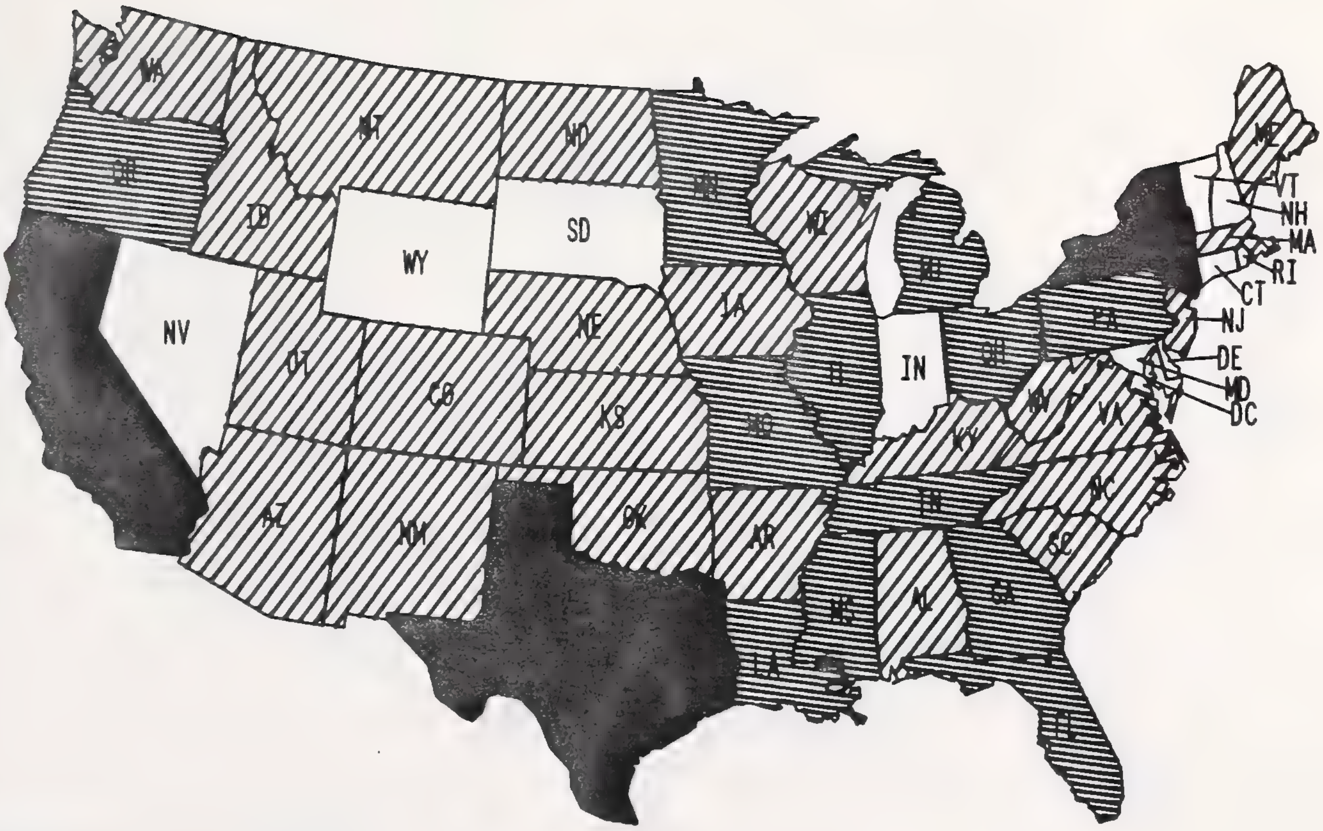
3.6 Market Exit and Entry

The entry and exit of firms to and from markets is another element of market structure that affects firms' behavior. When new hospitals open for business they draw doctors and patients away from existing facilities which may have to change competitive strategies to hold on to the more profitable market segments. Similarly, when hospitals exit a market they leave a segment open for competition, even if they were small and underutilized. The 1980s have been a time of many changes in the acute-care hospital industry. Figure 3-1 shows the concentration of closures, the most numerous type of exit (the other being changes from acute-care status to specialty status) that occurred in both the non-waivered and waivered states, excluding Alaska and Hawaii. The states with the most closures were the three largest: California, Texas, and New York, with more than 20 in each. The other states that experienced many closures were clustered in the East North Central and Southern regions of the country. Figure 3-2 shows that hospital openings also tended to be concentrated in may of these same states, particularly California, Texas, Louisiana and Florida.

A report on changes in the status of acute-care hospitals is included in the final report of this project. The reader is directed to that paper

FIGURE 3-1

DISTRIBUTION OF CLOSURES BY STATE 1980-1985*

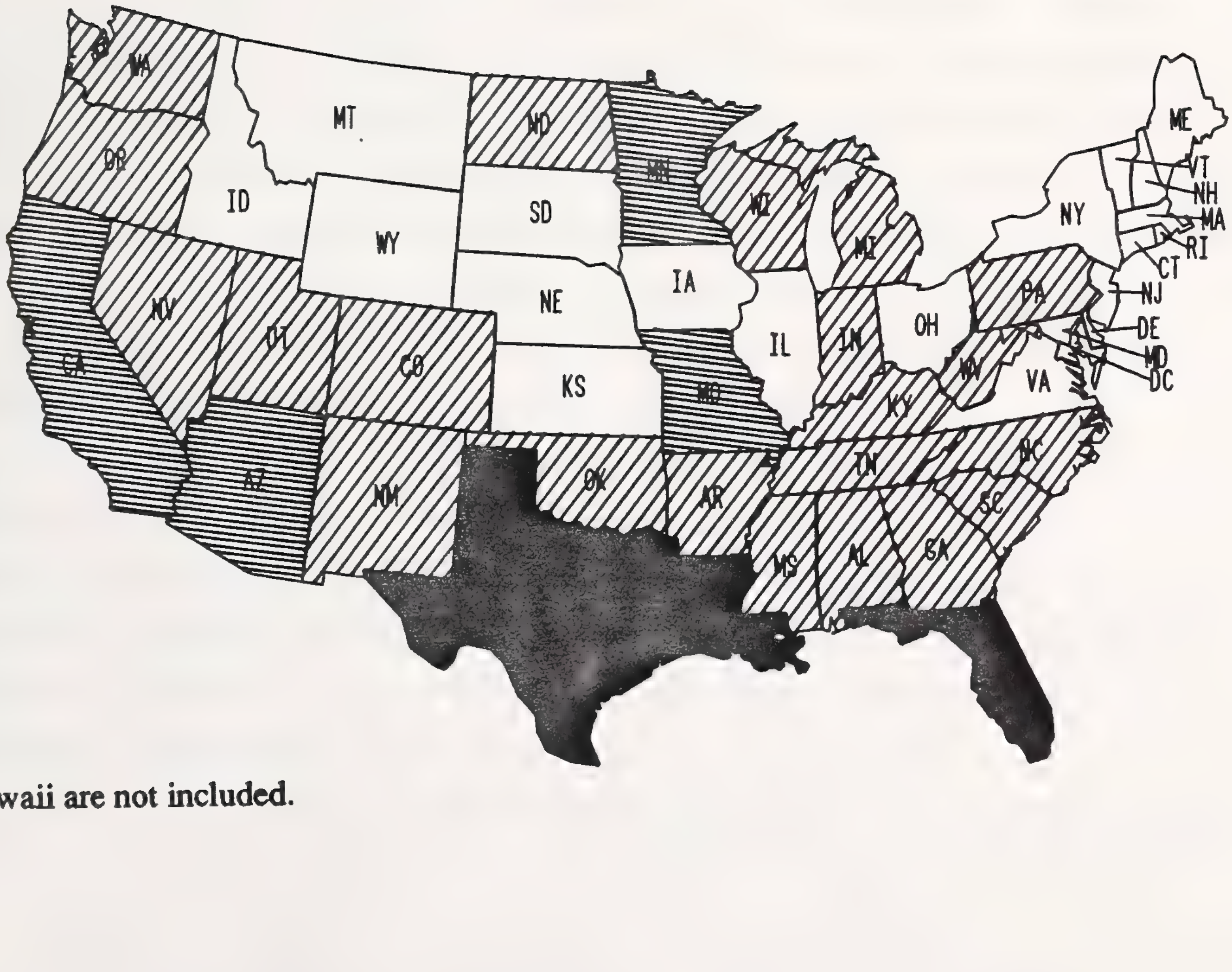


*Alaska and Hawaii are not included.

CLOSURES ■ OVER 20 ▤ 6-20 ▨ 1-5 ☐ NONE

FIGURE 3-2

DISTRIBUTION OF OPENINGS BY STATE 1980-1986*



*Alaska and Hawaii are not included.

(Hendricks, Dresser, et al., 1988) for a more complete description of the hospitals entering or exiting markets during this period. This section is an overview of the points made in that report, and also extends the description to the market areas themselves.

With respect to time, hospital changes in the four waivered states were spread fairly evenly across the 1980-86 period. Closures in these four states averaged five per year through 1985. In non-waivered states, however, closures increased significantly in 1984. That is, closures fluctuated from 26 to 32 per year from 1980 to 1983 and then jumped to 57 a year for the first two calendar years under prospective payment. This is double the average for the prior four years.

Time trends for openings and other changes in status are not evident. The annual average number of openings is just under 13 for both pre- and post-PPS periods. Neither period had a steady flow of openings, however. The counts swing from single digits to over 20 and back again. In contrast, the number of hospitals changing from acute to specialty care is fairly constant at two to four annually, with the exception of 1982, when eight hospitals switched. These latter changes occurred the year before the announcement of PPS and cannot be attributed to it, but came after the TEFRA regulations.

In sum, far more hospitals have disappeared from the acute-care industry during the 1980s than have been added to it. These reductions in bed capacity have been offset somewhat by hospitals opening, which tended to occur in urban areas. In rural areas, however, closing hospitals removed almost eight times as many beds as new hospitals replaced (3,167 versus 459).

Across the nine Census divisions, three actually had net gains in the numbers of acute-care beds. These were the South Atlantic, West South Central, and Mountain states. All three are attributable to opening urban hospitals. The East North Central and Pacific states had the greatest decrease in capacity, over 2,000 beds in each case. These losses were due primarily to large urban closures.

Many urban markets had both exits and entries. Los Angeles, for example

lost 23 acute-care facilities between 1980 and 1985 but had 8 that opened. Most of these most active markets were in the South (Texas, Louisiana, and Florida) or in the North Central states (e.g., Minneapolis and Detroit). Table 3-11 presents descriptive means for urban markets (MSAs) with exits, entries, or neither type of change in three years pre-PPS and two post-PPS years. The number of exits remained roughly the same but only two-thirds as many had entries post-PPs although the numbers of hospitals was still high in 1984 and 1985. There is some overlap between the markets in the exit and entry columns.

Urban markets with entries or exits tended to have higher (by two to eleven percent on average depending on the year) per capita incomes than markets with no such activity. Although they had higher population densities than markets with no activity (four and five thousand versus three thousand people per square mile), they had more physicians per capita and four times as many hospitals, as well.

A priori one expects new hospitals to be in the most rapidly growing population areas (although we do not control for other expansions of capacity here) and exits to be from shrinking markets. The first presumption is confirmed both pre- and post-PPS. Entries are following population growth. Exits, on the other hand, occurred in markets with more rapid population growth than the inactive markets but only two-thirds the rates in the MSAs with entries. This pattern is as apparent after PPS as in the years prior to the regulatory change. This is consistent with the notion that urban closures and other exits are due largely to competitive pressures. Hendricks, Dresser, Alberts, and Stone (1988) found that these were dispropotrtionately very small institutions and that they were often replaced by larger hospitals.

In rural areas, both exits and entries appear to be following movements in populations more than urban changes have (See Table 3-12). Population growth in rural markets with entries was also markedly higher than in other rural markets both before and after PPS however exits, especially post-PPS are more associated with slower growth or even a smaller decline in population.

TABLE 3-11

EAN DESCRIPTIVE VALUES FOR NONWAIVERED URBAN MARKETS WITH EXIT/ENTRY PRE/POST PPS

	PRE-PPS (1981-83)			POST-PPS (1984-85)		
	Markets with Exit	Markets with Entry	Markets with Neither	Markets with Exit	Markets with Entry	Markets with Neither
Number of Markets	44	34	219	43	24	229
Per capita Income						
1980	$ 9,666	$ 9,457	$ 9,020	$ 9,503	$ 9,942	$ 8,999
1984	12,223	12,510	11,947	12,651	13,261	11,899
Physicians/100 pop						
1980	.161	.167	.154	.154	.163	.156
1985	.182	.190	.175	.174	.182	.177
Population Density*						
1980	4.97	3.76	2.60	4.85	4.21	2.61
1983	5.14	3.97	2.66	5.02	4.51	2.68
1985	5.27	4.08	2.70	5.14	4.69	2.72
opulation Growth						
1980-83	4.3%	6.9%	3.5%	4.4%	7.7%	3.6%
1983-85	2.6	3.3	1.7	2.5	4.0	1.8
Number of short-term general hospitals in market 1985	24	22	6	22	26	7

*1000s per square mile

Source: Merged AHA Annual Surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

KLR677121988,KLR689121088,KLR691121988,KLR814123088

TABLE 3-12

AN DESCRIPTIVE VALUES FOR NONWAIVERED RURAL MARKETS WITH EXIT/ENTRY PRE/POST PPS

	PRE-PPS (1981-83)			POST-PPS (1984-85)		
	Markets with Exit	Markets with Entry	Markets with Neither	Markets with Exit	Markets with Entry	Markets with Neither
Number of Markets	51	8	1822	59	4	1810
Per capita Income						
1980	$ 7,434	$ 6,840	$ 7,514	$ 7,684	$ 6,710	$ 7,504
1984	10,081	9,306	10,137	10,163	8,954	10,130
Physicians/100 pop						
1980	.076	.064	.067	.064	.056	.067
1985	.087	.082	.075	.073	.076	.075
Population Density*						
1980	0.50	0.61	0.39	0.33	0.42	0.40
1983	0.51	0.64	0.40	0.34	0.44	0.41
1985	0.52	0.66	0.40	0.34	0.44	0.41
Population Growth						
1980-83	2.5%	3.9%	2.5%	3.9%	5.7%	2.4%
1983-85	0.9	1.7	0.1	-0.3	3.4	0.2
Number of short-term general hospitals in market 1985	2	3	1	2	3	1

*1000s per square mile

Source: Merged AHA Annual Surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

KLR793122988

With respect to other demographic characteristics, rural counties with exits in either time period had roughly the same per capita incomes and numbers of physicians than did markets with no exit or entry. They were somewhat more densly populated for those closing pre-PPS but less so post-PPS. The few rural counties occurred in somewhat poorer counties with low proportions of physicians in 1980s but a rapid growth rate so that the proportions were equivilent by 1985. These were also the larger rural counties in terms of both population density and numbers of hospitals.

4.0 THE RELATIONSHIP OF MARKET STRUCTURE TO HOSPITAL CONDUCT

Prior to the introduction of PPS, most acute-care hospitals operated in a fairly generous regulatory payment environment: Medicare reimbursed at reasonable cost, Medicaid programs had not yet cut funding for patient care, and most state regulatory systems were not unduly restrictive. Hospitals' competitive behavior, given the price-inelasticity of demand due (in part) to the prevalence of third-party payors, has been hypothesized by some analysts to have been rather like that in a price-regulated airline industry: quantity demanded in both industries depended on the quality of the meals, and on other non-price attributes of the services offered.

Much of the competitive behavior of hospitals during this period was undoubtedly aimed at physicians, indirectly attracting patients through referrals. Direct competition for patients has intensified during the last decade, however, leading to the redecoration of facilities, catered meal services, and even patient relations programs to improve customer/patient satisfaction.

Whatever its form, non-price competition for inpatients is thought to have contributed to higher costs in market areas with more hospital providers through competitively-motivated increases in the hospitals' scope of services, increased staffing, and more amenities for physicians, and even patients. A number of studies using pre-1983 data have indicated that this was the case (Robinson and Luft, 1986; Farley, 1985; Hersch, 1984; among others). These studies labelled markets with more hospitals in them as being competitive and most pooled urban and rural markets. Despite the use of the number of firms to classify the markets, not one of these studies claimed that a large number of hospitals implied a competitive market structure. Rather, they sought to demonstrate the results of a greater degree of competitive behavior that was supposedly engendered by a larger number of providers.

Farley, for example, divided his sample into three groups of hospitals: monopolistic (one hospital in the county), competitive (at least five or six

similarly sized facilities), and a middle group. The monopolistic and competitive groups were compared and a statistically significant differential in costs was found. Because five or six hospitals cannot be said to constitute a competitive market structure in which no agent can affect the terms of trade in the market (the definition established in Chapter 1, above), the appellation must refer to the hospitals' behavior with respect to non-price aspects of the market. Indeed, Farley's report "generally supports the conventional wisdom that hospital competition has increased costs...." (p. 17) but the implicit argument is not that the market structure is competitive but that the firms' behavior is. Robinson and Luft similarly found that the least concentrated markets had higher costs than monopolistic markets, as did Hersch, supporting the hypothesis that hospitals compete largely by non-price means.

Given the higher costs prior to the regulatory changes of the 1980s (including but not limited to Medicare's PPS), one might expect that hospitals in higher cost areas (less concentrated markets according to previous studies) would control costs more and experience a decrease or at least a lower increase in costs from 1983 on. Robinson and Luft (1988) present evidence that hospitals with ten or more hospitals within a 24 kilometer radius held their cost increases markedly below those for hospitals in more concentrated markets. For example, in all but five states (the four waivered states plus California), cost increases (adjusted for a number of hospital level factors) in markets with ten or more hospitals were nine points below those in the less concentrated markets. In California and the waivered states, the difference in cost inflation between the large and small markets was even greater.

One problem with this dichotomy of markets is that it confuses urban and rural differences with those due to the numbers of rivals in the geographic markets. Rural hospitals tend to have monopolies within their own counties, as we have demonstrated in Chapter 3. While even these county monopolists face competitive pressures from rivals in surrounding counties, especially if the monopolies are next to metropolitan areas, they tend to have fewer than

ten rivals within the radius used by Robinson and Luft. Therefore, what is ascribed to competitive market conditions may be due to other differences between urban and rural hospitals, differences such as falling occupancy rates and whether a hospital can maintain a minimum efficient size. This is addressed below.

In addition, two other problems arise with the Robinson and Luft analysis. First, they compared California, the most costly state in the nation (for Medicare costs standardized for casemix, wages, etc.), with all other states that were paid under the flat, average-cost prospective payment rate. _A priori_, one would expect hospitals in all high cost states to be under financial pressure to hold cost increases to a minimum post-PPS. Therefore, the correct comparison group would be other high-cost states, not all non-waivered states. Second, the 1982 to 1986 period studied by Robinson and Luft contains at most two fiscal years after the inception of PPS. The overview of Guterman, Eggers, _et al_., (1988) of the impact of PPS on hospitals and interviews with hospital executives in 1987 and 1988 indicate that the response of hospitals in the first year of PPS was more dramatic than what has followed. Therefore, the question is whether the Robinson and Luft results would hold for a longer period.

This chapter's analyses assume that the effects of market concentration in urban and rural areas are likely to differ and to be discontinuous, beginning at some threshold, perhaps as low as only two hospitals in a market but more likely above that. The basic hypothesis to be tested is that, prior to PPS, hospitals in markets with many hospitals did have higher costs per case, even holding other cost factors constant. As the transition to fully national rates proceeded, hospitals in these markets are expected to cut lengths of stay more (remember, they were longer in part due to the competition for patients) and hold the line on costs to a greater extent than hospitals in less populated markets. In the long run, even with flat rate reimbursement, as long as the demand for medical care remains relatively price inelastic, we expect to see somewhat higher costs to persist in these markets

compared to those with fewer providers because non-price competition will not disappear. However, the differential should be lower than on the eve of PPS because the financial incentives to control costs will continue.

Section 4.1 examines the evidence that a larger number of hospitals leads to higher costs. Section 4.2 shows whether those markets then experienced a greater reduction in costs per case following the inception of prospective payment by Medicare. The degree to which cost increases or decreases may be related to reductions in average lengths of stay is also examined. Section 4.2 also demonstrates the question of how PPS may have affected hospitals' financial positions in different types of markets. Finally, Section 4.3 explores how PPS may have affected the structures of hospital markets.

4.1 Are Hospitals in Less Concentrated Markets More Costly?

This section explores the relationship between market structure and average costs per case in urban and rural hospital markets in the non-waivered states for the hospitals' fiscal year covered by TEFRA regulations, i.e. the year before going onto PPS. Chapter 3 established the differences in the concentration of urban and rural hospital markets. It is also demonstrated that, while HMOs have increased both in numbers and membership, they are still largely found in the largest metropolitan areas. Finally, Section 3.6 showed in how few markets entry and exit have taken place and that those markets differed from the ones with no entry or exit. Some of these elements are expected to affect costs because they affect competitive strategies. Other elements may be the result of past hospital conduct, so the causality could be from behaviors that raised costs to the structural elements rather than vice versa.

4.1.1 Methodology

The conceptual model underlying the analyses that follow is based on the

notion that hospital markets have structures that range from monopolistic to monopolistically competitive but that they are never competitive market structures in the sense that we defined them in Chapter 1. In hospital markets, there are always dominant hospitals that have some market power. This means that competitive strategy or behavior is very important in all hospital markets but there will be a difference between the strategies for oligopolies (in which the hospitals are mutually interdependent) and the less concentrated markets in which product differentiation, to distinguish one hospital's service from that of another, is of paramount importance.

Horizontal integration concentrates sellers' market power. Given the ability to coordinate strategies for facilities after they have merged or affiliated, the integrated hospitals may then obtain a dominant firm position in the market. This may increase the level of non-price rivalry in the market if there are a number of large competitors in the market. In other markets, however, the integration may be sufficient to change a monopolistically competitive market to an oligopolistic one, reducing the level of rivalry in some markets at the least.

Product differentiation is another key to understanding the rivalry among hospitals. Hospitals are perceived as being different because of religious affiliation, the quality of the personal service or nursing the patient receives, the quality of the medical staff, and the level of the medical technology available. For example, to some, a hospital performing the latest techniques in neurosurgery will be better able to repair a hernia as well. Hospital executives have stressed in interviews the importance of establishing a set of services to promote their hospitals' image in the community. This type of differentiation, which is aimed at both physicians and patients, is presumably very costly because it entails investment and hiring additional, specialized, staff.

Entry and exit are also elements of market structure that require very complex investment or disinvestment decisions in any industry. For hospitals, the decisions are further complicated by regulations and political interests.

For example, many states attempt to control the industry through certificates of need for additional beds. In addition, local governments may promote entry or bar exit (by buying the hospital if the community wants the hospital and a for-profit company wants to close). Finally, other hospitals in the market may try to bar entry or, conceivably, exit depending on their own competitive strategies.

Our interest is how entry and exit affect the behavior of other hospitals in the market. Because these decisions occur selectively, however, there is serious question about their relationship to costs. The descriptive work in Chapter 3 and in the report on changes of status indicate that for the 1980s, the largest urban markets had both entry and exit. Further, both types of change occurred predominantly in the South and Southwest, regions that have historically had lower medical costs and less regulation but which have seen the greatest population growth in the last twenty years. The former relationship may lead us to expect higher costs in markets with change. The latter suggests the costs will be lower.

Finally, buyer concentration or countervailing market power is also expected to affect the behaviors that raise or lower hospitals' costs. Where cost-conscious insurors and physicians strive to hold costs down or force hospitals to compete on price (raising the price elasticity of demand for those market segments) there should be an effect on market costs at the aggregate level if the cost-conscious buying agents are a large market bloc. However, these agents are expected to self-select for entry into the most costly markets, where they can gain an advantage in selling their services to the patient population. Therefore the presence of HMOs will tend to be in high-cost urban areas but MSAs with large HMO enrollments (absolute, not relative) should have lower costs.

More formally stated, the per case costs of competitive behaviors (cc) such as advertising, acquition of the latest technology to attract physicians,

additional nursing support, etc. will depend on the structurtal elements of the market in which the hospital operates:

$$cc = c(NUMRIV, MKTSHAR, HORINT, DIFFER, ENTRY, EXIT, BUYERS) \qquad (4-1)$$

where the independent factors and the expected sign of their effects on the costs of competing (in paranthesis) are:

NUMRIV = number of all rivals in the market (+)
MKTSHAR = the hospital's own share of the market (-)
HORINT = The degree of horizontal integration among all rivals (-)
DIFFER = the degree of product differentiation in the market (+)
ENTRY, EXIT = whether the market has low barriers to entry or exit (-)
BUYERS = The degree of buyer concentration (-)

From this conceptual model, there are four basic hypotheses concerning average total costs to test:

1) Hospitals in less concentrated markets with fewer rivals will have significantly higher average costs per case, *ceteris paribus*;

2) Hospitals in markets with HMOs (in this dataset, the only identifiable buyers of hospital services that might exert countervailing power) will have higher costs due to self-selection;

3) Hospitals will have lower costs if the numbers enrolled in HMOs are greater due to more buyer power;

4) Hospitals that are in markets that are more differentiated in their products will have higher costs.

In addition, the relationship of three other elements of market structure to average costs will be explored. The hypotheses are:

5) Hospitals in markets with more pre-TEFRA entry will have lower costs under TEFRA because these markets are the ones where investment in new hospitals is easiest and most profitable;

6) Hospitals in markets with more exit activity prior to TEFRA will have lower costs because these markets are in the South and Southwest;

7) Hospitals in markets with horizontal integration due to multihospital system affiliations will have lower costs ceteris paribus, because system affiliation will concentrate the markets, reducing the level of non-price competition;

To test whether average costs per case are higher in some types of hospital markets, we estimated several multivariate regressions of average cost per case under TEFRA, holding constant hospital, area, and market structure characteristics. The basic reduced-form behavior cost equation relates hospitals' average cost per case to exogenous factors reflecting relative input prices, the mix of products associated with each facility, and the market characteristics delienated above. The specification used is:

$$AC = Ae^{(Sa_i S_i)} . e^{(S_j B_j Y_{jh})} . W_l^S . X_j^\gamma . B_h^\theta . e^{mh} \tag{4-2}$$

where S_i are 0,1 dummies for location in markets with different degrees of seller concentration (monopoly, oligopoly, etc.); W_l = aggregated hourly labor costs for each hospital's HCFA-defined labor market area; X_j = a vector of hospital-specific measures of the mix of cases treated and other activities; Y_{jh} = a vector of other market characteristics representing unexplained geographic cost differences, if they exist; B = the number of staffed beds; and m = a residual error term. Taking the natural logarithms of both sides of equation 4-2 gives a specification estimable by ordinary least squares:

$$\ln AC = \ln A + \Sigma_i a_i S_i + \Sigma_j B_j Y_{jh} + \delta \ln W_l + \Sigma_j \gamma_j X_{jh} + \theta \ln B_h + m_h \tag{4-3}$$

The coefficients a_i form the test that the costs of hospitals in various market categories are higher than those in the comparison category; thus, the expectation is that the $S_i = 0$ relative to the intercept.

This approach recognizes that hospitals are multiproduct firms: inpatient cases are not homogeneous with respect either to diagnoses or treatment; teaching also raises costs per case. Lacking an index that

aggregates across weighted combinations of diagnoses, we control for the mix of Medicare cases through the Medicare casemix index. This is highly correlated with the severity of non-Medicare cases.

Medical residents are a recognized product of hospitals with teaching programs. Medical training requires costly effort and inputs by hospital staff, although the labor of the residents themselves may lead to overall savings, in theory. This output is held constant through the size of the residency program as measured by the number of residents per bed.

The only measure of factor prices available for this model is the HCFA wage index of hourly aggregate wages in 1982. If wages in one area are higher than in another, hospital costs per case will be higher. Other research has shown that this variable is highly significant in explaining hospital costs, perhaps capturing the effects of other relative prices as well.

The quantity of inpatient care is measured by the hospital's bedsize combined with the occupancy rate. Greater bedsize may lead to higher costs because it increases the size of the staff and other inputs required to operate the hospital. Higher occupancy should lower average costs through some threshold reached because staff and equipment can be used more efficiently above some minimum staffing level. Variables measuring the market elements include the Herfindahl Index (described in Chapter 2) of market concentration among sellers, the number of HMOs in the market, the level of HMO enrollment in the market, whether a hospital was a flagship hospital offering at least one of four special services (organ transplants, burn care, neonatal intensive care, or trauma), the bedsize of the flagship hospitals, the proportion of hospitals in the market that are flagship hospitals (in urban markets) to capture whether non-price competition intensifies where more flagship hospitals are competing (controlling for the size of the market), whether there was entry into the market between 1980 and 1983 (defined as a hospital opening or changing to acute-care status from offering alcohol, psychiatric, etc. service), and whether there was exit from the market between 1980 and 1983 due to hospitals closing or changing to non-acute-care status.

The Herfindahl Index was not entered as a continuous measure of market

concentration. Chapter 3 described the distribution of Herfindahl values across markets. For urban markets, we have followed the guidelines of the Antitrust Division of the Justice Department to define five categories of markets in which we believe that the degree of non-price rivalry might be different (0.3 and greater, .18 to .3, .1 to .18, .05 to .1, and below .05). Table 4-1 shows that 16 percent of the urban hospitals were in markets with index values of 0.3 or more; 19 percent, in oligopolistic markets (a minimum of three to six equally-sized hospitals); and 18 percent, in markets with roughly six to ten competitors of equal size (HI = .1 to .18).* Because it was so large, we divided the Antitrust guidelines category below .1 into those markets with Herfindahls of .05 and less versus those with values between .05 and .1. This differentiated the largest cities with the most hospitals from all other markets.

Rural markets are smaller than urban ones and the maximum number of rural competitors was six (see Table 3-1). Therefore the degrees of rural seller concentration were monopolies (51 percent of all rural hospitals analyzed), duopolies with Index values of 0.5 up to 1.0 (32 percent of all rural facilities), small oligopolies (14 percent in markets with at least two or three hospitals of equal size) and oligopolies with up to six hospitals.

In addition to the market elements and cost factors described above,this analysis controlled for the chronological time within which hospitals started their TEFRA fiscal years. Because a hospital's payments were covered by the regulations of TEFRA in its fiscal year beginning after October, 1982, it was possible that almost a full year could exist between the analysis years for different hospitals (one could begin in October 1982, another in September 1983). Therefore, a dummy variable to differentiate those hospitals with a fiscal year beginning after April 1983 measures the inflation that may have been attributable to the later chronological period.

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*Where competing hospitals have greatly different sizes, more than the indicated number of hospitals will yield Herfindahl Indexes in the various categories of seller concentration.

4.1.2 Empirical Results

The units of observation are 4,600 hospitals in the non-waivered states. The dataset is described more fully in Chapter 2. Table 4-1 presents variable definitions and mean values for the hospitals' TEFRA fiscal years, the last fiscal year before the hospitals' Medicare payments were determined under the prospective payment system. The mean logs for urban and rural average cost per case are 7.96 and 7.56, respectively. The anti-logs are shown in parentheses and are $2,864 per case for the average urban hospital and $1,920 for the average rural one. Part of this differential is due to the higher average urban casemix (1.06 versus 0.97), higher relative wages (1.05 versus 0.86), teaching activity, and bedsize (179 versus 57 beds). Urban hospitals had an average TEFRA occupancy rate of 63 percent compared to only 48 percent in rural hospitals. Forty-four percent of both groups had late-starting fiscal years.

With respect to market elements, urban hospital markets differ considerably from those in rural areas. HMO penetration is negligible in rural areas, compared to the 47 percent of urban hospitals in markets with HMOs. Horizontal integration due to multiple hospitals affiliated with the same multihospital system is also negligible in rural hospital markets, in part because the majority are monopolies. Average costs for urban hospitals were tested separately from those of rural hospitals because previous regressions indicated that the relationship of structure to costs was significantly different.

Urban Hospitals in TEFRA

Table 4-2 presents three stepwise regressions explaining average inpatient cost per case for urban hospitals in their TEFRA years. Explanatory variables are in three groups: the degree of seller concentration, hospital cost factors, and other elements of the markets' structures. By stepping in

TABLE 4-1

VARIABLE DEFINITIONS AND MEAN VALUES ACROSS URBAN HOSPITALS

	URBAN		RURAL	
	Mean	Standard Deviation	Mean[a]	Standard Deviation
Natural Log of Average Cost Per Case (TEFRA)	7.96 ($2,864)	0.33	7.56 ($1,920)	0.31
Degree of Seller Concentration				
Monopolistic competition = .05 < HI ≤ .10	0.15	0.36	N/A	N/A
Some Monopolistic Competition = .10 < HI ≤ .18	0.18	0.38	N/A	N/A
Oligopolistic HI = .18 to .3	0.19	0.39	0.04	0.19
Monopoly/Oligopoly HI = .3-1.0 urban;.3-.5, rural.	0.16	0.37	0.14	0.35
Duopoly = .5 ≤ HI < 1.0 (rural only)			0.32	0.47
Monopoly = HI = 1.0 (rural only)			0.51	0.50
Hospital Cost Factors				
Medicare Casemix Index=Log of Medicare CMI	0.06 (1.062)	0.10	-0.03 (.97)	0.07
Relative Wages = Log of HCFA Wage Index, Fiscal 1987, 1982 data.	0.05 (1.050)	0.12	-0.15 (.86)	0.10
Teaching = Log of (1+ ratio of residents/beds)	0.03 (1.031)	0.07	b	0.02
Bedsize = Log of HCFA staffed beds	5.19 (179)	0.81	4.04 (57)	0.73
Occupancy Rate = Total inpatient days/(beds*365)	-0.47 (.63)	0.28	-0.74 (.48)	0.39
Late Fiscal Year = FY started after March 31, 1983	0.44	0.50	0.44	0.50
Elements of Market Structure				
HMO(s) in Market = 1 if 1 or more HMOs	0.47	0.50	0.01	0.08
HMO Enrollment = Log of HMO membership	7.26 (1,422)	4.82	1.01 (2.8)	2.28
Flagship Hospital = 1 if Hospital has one of 4 special services	0.36	0.48	0.11	0.31
Flagship Bedsize = HCFA staffed beds for flagship hospitals	2.06 (81)	2.78	0.51 (2)	1.49
Proportion of Flagship Hospitals = # Flagship / # Hospitals	0.35	0.17	0.11	0.27
Market Entry = 1 if any hospital opened or became acute care in 1981-3 in that market	0.32	0.47	b	0.07
Market Exit = 1 if any hospital closed or became exempt in 1981-3 in that market	0.32	0.48	0.02	0.14
System Integration = Difference in Herfindahl if multiple hospitals and in same system	0.68	0.47	0.03	0.17

[a] Antilogatithmic values in parenthesis
[b] Less than .005

TABLE 4-2

EXPLAINING INPATIENT COST PER CASE, URBAN HOSPITALS, TEFRA[a]

	(1)	(2)	(3)
Constant[b]	8.10***	7.31***	7.37***
Degree of Seller Concentration[c]			
Monopolistic competition	-0.11***	-0.04**	-0.05**
Some Monopolistic Competition	-0.19***	-0.06***	-0.07***
Oligopolistic	-0.26***	-0.09***	-0.10***
Monopoly/Oligopoly	-0.31***	-0.10***	-0.10***
Hospital Cost Factors			
Medicare Casemix Index		0.68***	0.69***
Relative Wages		0.92***	0.91***
Teaching		1.18***	1.14***
Bedsize		0.09***	0.09***
Occupancy Rate		-0.19***	-0.18***
Late Fiscal Year		0.08***	0.08***
Elements of Market Structure			
HMO(s) in Market			0.12***
HMO Enrollment			-0.01***
Flagship Hospital			0.10
Flagship Bedsize			-0.02
Proportion of Flagship Hospitals			-0.06
Market Entry			-0.03**
Market Exit			-0.04**
System Integration			-0.01
R^2	.13	.48	.50
F Value	58	148	89

N=1607

[a] The dependent variable is the natural log of total inpatient cost per admission adjusted for outpatient volumes.

[b] Hospitals in markets with lowest seller concentration (Herfindahl Indexes = 0 to .05) in intercept.

[c] Degrees of urban seller concentration are defined as:
Monopolistic competition: HI = .05-.10.
Some monopolistic competition: HI = .1-.18.
Oligopolistic: HI = .18-.3.
Monopoly/Oligopoly = .3-1.0.
The least concentrated (HI < .05) are in the constant.

***Significant at one percent level.
**Significant at five percent level.

EXK80512988.

Sources: Merged Medicare Cost Reports, Impact File, Provider of Service File, and AHA Annual Survey data.

each group of variables, we can ascertain not only significant differences in costs across markets but also the amount of the differentials that are associated with differences in hospital or other market characteristics.

Column (1) presents the estimates of the percentage differences in average total cost per case between hospitals in the least concentrated markets and those in the four market categories for which the Herfindahl Index for the MSA was greater than 0.05. The coefficients are the difference in natural logarithms between each group and the excluded group.* The anti-logarithm for the constant term is approximately $3,300, representing the geometric mean cost per case in the least concentrated markets with a Herfindahl Index of 0.05 or less (20 or more hospitals). The fact that all four of the other hospital market groups are less costly than these least concentrated markets when no other factors are held constant is shown by the negative coefficients. The differences are significant at the one percent level. They range from twelve percent lower costs in markets with Herfindahl Indexes of 0.05 to 0.10 to 36 percent lower costs in the most concentrated urban markets.

Separate statistical analyses (not shown) confirm that these levels of costs are significantly different from each other with the exception of the two most concentrated groups for which the Herfindahl Index is over 0.18 (labelled the oligopolistic and monopoly/oligopoly markets). These market Categories, with no other cost factors taken into account, have the same average costs, statistically speaking.

Market concentration alone "explains" 13 percent of the variance in average hospital costs. The F value of 58 indicates that as a group they are significant explanatory variables. However, column (2) shows that much of this explanatory power is due to differences in the other characteristics of the hospitals that are located in markets of different sizes. When hospital cost factors such as the mix of cases, relative wages, the intensity of

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*Researchers generally interpret dummy variable coefficients in semilogarithmic equations as arithmetic percentage differences. Halvoren and Palmquist (1980), however, demonstrate a bias using the unadjusted coefficients, which increases with the size of the difference. In fact, each coefficient (a) is an estimate of $a = \ln(1 + g)$ where 100g is the correct percentage differences. Exponentiating and solving for g gives $g = [\exp(a)-1]$. For $a = .05$, $g = .0513$, a trivial difference, whereas for $a = .50$, $g = .649$. All dummy coefficients discussed in the text are therefore transformed into simple arithmetic differences using $g = [\exp(a)-1]$.

teaching activities, the scale of production (measured by bedsize and the occupancy rate), and whether the hospital started its TEFRA year late in the 1983 fiscal period are taken into account, the cost differential between hospitals in the least concentrated markets and each of the other four concentration categories shrinks to one third its previous size. For example, the differential between the least concentrated and most concentrated markets shrinks from 36 percent (exponentiated regression coefficient of -0.31) to eleven percent (exponentiated regression coefficient of -0.10). When the hospital-level cost factors are controlled for, the hospitals in the least concentrated markets are still significantly more costly than those in the other market categories. The differential between the excluded category and the next least-concentrated category (monopolistically competitive markets) is significant at only the five percent confidence level, however.

Column (2) in Table 4-2 shows that hospitals in other markets are less costly than those in the least concentrated MSAs. A parallel set of regressions (not shown) omitting a different market group, shows that hospital costs in the two most concentrated categories of urban markets (oligopolies and monopolies) are not significantly different from each other and can only be considered significantly lower than the markets with some monopolistic competition (HI = .10 - .18) at the ten percent confidence level. The differences in costs between the two least concentrated and two most concentrated market categories are highly significant. Therefore, there appear to be three steps in the relationship of seller concentration to costs: the least concentrated have significantly higher costs than all other groups; the next least concentrated also have significantly higher costs than hospitals in markets with Herfindahls above 0.1; the latter have the lowest average costs.

These results confirm the findings of Farley (1985) and Robinson and Luft (1986) that markets with more hospitals have higher average costs, ceteris paribus. We cannot reject the hypothesis that this is due to non-price competition. However, the non-price competition might be due to

other structural elements of the markets that are correlated with the number of hospitals in the MSA. It may also be due to unmeasured severity or relative input costs that cannot yet be measured.

The coefficients for the hospital cost factors are interesting in their own right. All are highly significant factors, both individually (at the one percent confidence level) and collectively (F value of 148). Further, the R-squared has increased from .13 to .48, with the hospital factors explaining an additional third of the total variance in average costs over and above the market concentration measures. Average costs should be higher if the hospital treats more patients with severe or complicated diagnoses. Regression (2) shows that costs per case rise 0.68 percent for each percentage increase in the Medicare casemix index. If these were only Medicare cases, we would expect the coefficient to be 1.0. However, the average severity of non-Medicare cases is lower, therefore the predicted rise in costs is not as great.

The relative wages for the MSA raises costs almost one for one. Labor is only about 75 percent of hospital operating costs but other costs are correlated with them, perhaps increasing the variable's coefficient estimate. The estimated impact of urban teaching activity is also positive and highly significant. Because the cost variable includes capital, the coefficient of 1.18 appears to capture the high cost of equipment that is prevalent in teaching hospitals.

While average costs increase with bedsize, reflecting the higher capital and staffing costs of larger hospitals perhaps, they decrease with increases in the occupancy rate, a drop of about two percent for every ten percent increase in the mean occupancy rate. The dummy variable for having a late fiscal year, presumably accompanied by an extra six to eleven months of inflation, indicates that these hospitals were indeed eight percent more costly, on average, than those hospitals with fiscal years starting between October and April of the 1983 federal fiscal year, *ceteris paribus*.

Column (3) presents the coefficient estimates when a number of variables

proxying other elements of market structure are held constant. These structural proxies affect the coefficients for the urban market concentration variables only slightly and change their relative standings not at all. Hospitals in large markets with more than twenty rivals have average costs that are significantly higher (by five to eleven percent) than those in all other market categories. Hospitals labelled as having a greater degree of monopolistic competition are also significantly more costly than hospitals in the most concentrated urban markets. However, those in markets with Herfindahls of .1 or greater (from monopolies to those with ten or so rivals) still did not differ significantly from each other with respect to their average costs.

The conceptual model posits that HMOs will tend to enter high-cost MSAs but that they will exert effective countervailing market power only if they enroll a significant number of patients. To distinguish these effects, two variables were entered: a dummy variable that indicated the presence of any HMO in a market, and a variable with the total number of enrollees in that market. As expected, the coefficient for the HMO dummy variable is positive and highly significant. Urban markets with at least one HMO are 13 percent more costly per case than those with no HMOs. Average costs drop by a small but significant amount as the HMO enrollments increase from one market to another.

If a market had an entry or exit in the pre-TEFRA year (1981-83), the hospitals' average cost per case was about four percent lower (significant at the five percent level). This is interpreted at this stage of the analysis as a proxy for the South which contained some of the fastest growing markets and some of those hardest hit by recession in the early 1980s.

Rural Hospitals in TEFRA

A comparison of the regressions presented in Table 4-3 and those in 4-2 show that the variation in rural average total costs is not explained as well

TABLE 4-3

EXPLAINING INPATIENT COST PER CASE, RURAL HOSPITALS, TEFRA[a]

	(1)	(2)	(3)
Constant[b]	7.76***	7.47***	7.49***
Degree of Seller Concentration[c]			
Oligopoly	-0.15***	-0.05	-0.05
Duopoly	-0.20***	-0.08**	-0.08**
Monopoly	-0.24***	-0.10***	-0.09***
Hospital Cost Factors			
Medicare Casemix Index		0.96***	0.93***
Relative Wages		1.24***	1.22***
Teaching		0.97**	0.75
Bedsize		0.06***	0.05***
Occupancy Rate		-0.19***	-0.19***
Late Fiscal Year		0.03***	0.03***
Elements of Market Structure			
HMO(s) in Market			0.16**
HMO Enrollment			d
Flagship Hospital			-0.17
Flagship Bedsize			0.04
Market Entry			0.05
Market Exit			-0.01
R^2	.03	.27	.28
F Value	18	82	50

N=1945

[a] The dependent variable is the natural log of total inpatient cost per admission adjusted for outpatient volumes.

[b] Hospitals in markets with Herfindahl Indexes less than .30 in intercept.

[c] Degrees of rural seller concentration are defined as:
Oligopoly: HI at least .3 but less than .5.
Duopoly: HI at least .5 but less than 1.0.
Monopoly: HI = 1.0.

[d] Less than 0.005.

***Significant at one percent level.
**Significant at five percent level.

Sources: Merged Medicare Cost Reports, Impact File, Provider of Service File, and AHA Annual Survey data.

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by the regression models as the variation in urban costs. Across the three models presented, at best, we explained only a quarter to a half of the variation explained for urban markets. Similar trends for many of the cost factors explaining rural and urban costs are observed, nevertheless.

Rural hospitals in markets with Herfindahl Indexes between 0.3 and 0.18 are in the intercept. (When the rural market is taken to be the county, there were no markets with Herfindahls lower than 0.18.) Compared to this category, hospitals in all other markets are significantly less costly per case on average. The differences among the other three categories (from oligopolies to monopolies) are also significant at the one percent confidence level.

When hospital-specific variations in casemix, wages, teaching levels, size, occupancy, and fiscal year start date are controlled for econometrically, average costs per case in rural duopolies versus monopolies are not significantly different, but both are significantly lower than the costs in less concentrated rural markets with Herfindahl measures lower than 0.5. Rural hospitals in counties with only two acute-care facilities (whether those facilities are equal in size or not) appear not to engage in non-price competition to any greater degree than rural monopolies. This does not mean that they do not compete with each other but their most significant competition may be largely from the same sources (e.g., out-of-county, especially urban, hospitals; outpatient clinics; doctors' offices; etc.) as those facing rural monopolies. Rural hospitals in counties with three to six hospitals do have higher costs, ceteris paribus. This is in keeping with a greater degree of non-price competition in these markets.

Is this rivalry due merely to the greater number of rural rivals? Could it be due to competition from urban rivals? When proximity to an MSA was controlled for (not shown), the relationship in costs was unchanged, leading us to conclude that the greater costs in the larger rural markets is not due to greater competition from nearby urban markets.

Another explanation may be that these somewhat less concentrated rural markets are more populated and contain larger cities, even though they are

classified as rural. Examples of this would be Sioux Falls, South Dakota, and Minot, North Dakota, which were reclassified as MSAs after 1983, promoting over six, previously rural, acute-care facilities to urban status for PPS purposes. However, other large "rural" urbanized areas in 1983 do not fit this pattern.

A third possible explanation of higher costs for rural markets with three to six hospitals is that the rivals compete in the labor market more than the patient market, bidding up the average wage in those counties even though each maintains a relatively unique niche in the patient market. This supposition receives some support from the fact that the significance of cost differences across the market groups disappears when the HCFA relative wage index is stepped into the regression model. It is also supported by the size of the regression coefficient for the wage variable. The value of 1.24 is highly significant and is much larger than that in the regressions for urban hospital costs. However, because the rural wage index is defined for all rural hospitals in each state while the urban wage index is MSA specific, the wage variable may also be a proxy for other state level factors that are unmeasured.

Among the coefficients of the other hospital-level cost factors, all of which are statistically significant at the one percent level, there are several interesting differences from the results for urban markets. The coefficient for the rural Medicare casemix index has a higher value (approaching the 1.0 expected for a regression of Medicare costs). Because rural hospitals have higher proportions of Medicare patients and a more limited range of diagnoses, on average, the Medicare index may be a better proxy for the casemix of all rural inpatients compared to all urban inpatients. The impacts of teaching and bedsize on average total costs are somewhat less for rural versus urban costs. Again, the variation in these measures is less in rural than in urban areas.

Low occupancy rates contribute significantly to higher rural costs. The coefficient is identical with the measure for urban hospitals. For each one

percent increase in hospitals' occupancy, costs drop by 0.02 percent. Finally, rural hospitals with fiscal years starting six months later, on average, had experienced three percent inflation during their TEFRA years than those with earlier federal fiscal years, less than half the increase noted for urban hospitals.

Of the other market structure characteristics, only the presence of an HMO in the market was a significant explanatory variable. The coefficient of 0.16 is significant at the five percent level. It indicates that HMOs have entered only the more costly rural markets, on average. However, there are very few rural markets with HMOs and the enrollments are too small to vary significantly. Being a flagship hospital, offering one of four very technology intensive services (burn care, organ transplants, neonatal ICUs, or trauma), was highly correlated with having medical residents and made the teaching variable insignificant.

4.1.3 Conclusions

In sum, for both rural and urban hospitals, those in the least concentrated markets had significantly higher average total costs than hospitals in markets with fewer rivals. The relationships do not appear to be continuous but there are lower thresholds for the influence of seller concentration on costs in rural markets compared to urban ones.

Among the other proxies for elements of market structure only the presence of an HMO was a significant predictor of costs in both rural and urban markets. this coefficient is consistent with the hypothesis that HMOs enter the most costly rural and urban markets. Increased HMO enrollment is associated with lower average costs only in urban markets. Similarly, increased entry or exit activity is associated with significantly lower costs in urban markets but no significant differences in rural ones.

Among the hospital-level cost factors, only teaching activity was not significant in explaining both rural and urban costs. In rural markets, the

flagship hospitals also tended to be the costly teaching facilities, so the teaching measure was not significant once the rural flagsship hospitals were accounted for.

Overall, the reduced-form model employed for these analyses explained almost twice as much of the variation in average urban costs as in average rural costs. Two-thirds or more of the explanatory power is attributed to the hospital-level cost factors in both rural and urban markets, however.

4.2 Did Hospitals in Less Concentrated Markets Cut Costs More Post-PPS?

The empirical results presented in Section 4.1 indicate that hospitals in the least concentrated urban and rural markets did indeed have higher costs in their TEFRA fiscal years than hospitals in other markets. The number of hospitals in a market that were necessary to produce this result, which is frequently interpreted as the result of increased non-price rivalry, is markedly different in urban compared to rural areas, however. In urban markets ten or more hospitals in the same MSA are necessary to produce the higher costs while in rural markets, as few as three hospitals in the same county can produce a significant difference and no rural county had more than six hospitals.

A natural question that arises is whether the hospitals in these higher cost, less concentrated markets were able to contain their costs more than other hospitals following the advent of PPS. Because Medicare's fixed, flat-rate base payment was set at the national averages for urban and rural hospitals, hospitals with above-average costs, standardized for casemix, wages, and teaching activities, should have had strong incentives to cut costs more or, barring that, hold inflation below that incurred in other markets. These incentives should have been greater as the transition to fully national, federal rates progressed because a greater percentage of the hospitals' Medicare payments was based on the national averages each year until, in year four, the transition was complete.

This section addresses the question whether hospitals in less

concentrated, higher-cost markets contained costs more than other hospitals following PPS (subsection 4.2.1). The extent to which cost containment was due to reductions in average lengths of stay is explored in 4.2.2. Finally, the extent to which market concentration may have affected hospitals' financial margins from TEFRA through the third year of of PPS is the subject of 4.2.3.

4.2.1 Explaining Percentage Changes in Costs

Medicare's prospective payment system was designed to give all hospitals an incentive to contain costs per case. The incentive was the profit or loss that would arise, in theory, if a hospital's costs were below or above the flat-rate payment per case adjusted for wages, teaching, and the severity of the diagnoses as measured by the resource-based DRG weights. In the short run, there was an expectation that the threat of losses would be a greater motivation for most hospitals to reduce costs than would the promise of net profits. Therefore, one expectation was that high cost hospitals would reduce or at least curb inflation more than would hospitals with costs below the national urban or rural average. In addition, hospitals with a greater Medicare caseload, as a proportion of all inpatients, were expected a priori to reduce costs more because their ability to cross subsidize Medicare losses was less.

To the extent that market competition led to higher than average costs, hospitals in the less concentrated markets could be expected to contain costs more to reduce the threat of losses on Medicare patients. However, many other regulatory changes took place at roughly the same time as the change in prospective payment. Most notable was Medicare's reliance on peer review organizations (PROs) to monitor quality of care and police regulations against medically unnecessary hospital admissions (which presumably were low cost because actual medical treatment was nil and would therefore earn profits for the hospitals). The PROs reportedly had a major impact on hospitals' casemix,

shifting the treatment of many less severe cases to outpatient settings and increasing the casemix measure for Medicare patients, at least. This change would raise average costs per case above the basic rate of inflation due to increased input prices and must be controlled for in the analysis.

On the other hand, casemix indexes also increased because of changes in medical recordkeeping that improved the coding of complex cases. That is, complications and co-morbidities were included more often in the record codes and this increased the DRG weight assigned the average Medicare case, especially in the first year of prospective payment. One result of this upcoding was an increase in average prospective payments over the expected amount, lending to higher than expected net revenues and a potential disincentive to reduce costs in the short run.

Another complication comes from changes in state regulations around the time of PPS's start. Perhaps most notable was that of California, which instituted a state office to oversee price negotiations between the hospitals and the insurors. This system was expected to lower actual hospital charges and therefore contain costs through motives similar to those touched by PPS - the gain of profits or at least the avoidance of financial losses. Therefore, California hospitals should have had a double incentive to contain costs post-PPS.

Finally, average hospital costs could have increased because of changes in the various hospital- or area-level factors taken into account by the PPS payment formula and the analyses in section 4.1. These factors include changes in area wages and hospitals' teaching activities and occupancy rates. Any of these could have changed because of hospitals' cost containment measures or for other, unrelated reasons. Wage levels, for example, could be held constant as a containment measure but the average hourly payment might have increased because the hospitals laid off many of the lowest paid workers. Increases in teaching activities and reduction in occupancy rates would have increased average costs to the extent they occurred.

More formally, the percentage change in average hospital cost per case (%CSTCH) depends on :

$$\%CSTCH_i = f\ (RLCST_i, MDDP_i, SRGS_s, \%WGCH_m, \%TCHCH_i, \%OCCH_i) \quad (4\text{-}4)$$

where:

$\%CSTCH_i$ = the difference in average costs per case for hospital i between the PPS year and TEFRA as a percentage of the TEFRA year costs;

$RLVCST_i$ = the relative level of the i-th hospital's costs to the national average at the start of PPS

$MDDP_i$ = the i-th hospital's dependency on Medicare revenues measured by the proportion of its TEFRA discharges covered by Medicare;

$SRGS_s$ = other changes in state regulations of hospitals.

$\%WGCH_m$ = the percentage change in the relaitve hospital wages in market m;

$\%TCHCH_i$ = the o-th hospital's percentage increase/ decrease in medical residents per bed;

$\%OCCH_i$ = the percentage change in the i-th hospital's occupancy rate.

In the analyses that follow, no information was available to measure changes in wages or teaching activities. In addition, the relative average costs were defined only at the state level with twelve states identified as high cost states (New Hampshire, Vermont, Pennsylvania, the District of Columbia, Florida, Michigan, Illinois, Missouri, Kansas, Colorado, and California) and nine states identified as low cost states (Georgia, Kentucky, Tennessee, Mississippi, Oklahoma, North Dakota, Nebraska, Idaho, and Utah). California was further distinguished because of its change in state regulations coinciding with many hospitals' first or second year of prospective payment. Future analyses may identify and control for other state changes in the non-waivered states and incorporate the experiences of the waivered for this period as well.

Table 4-4 presents variable definitions, their mean values and standard deviations. The mean change in both urban and rural average total costs between the hospitals' TEFRA and PPS-1 fiscal years was an eleven percent

TABLE 4-4

VARIABLE DEFINITIONS AND MEAN VALUES

	URBAN				RURAL			
	TEFRA to PPS-1		TEFRA to PPS-3		TEFRA to PPS-1		TEFRA to PPS-3	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Change in Average Cost	0.11	0.21	0.41	0.47	0.11	0.22	0.45	0.41
Change in Average LOS	-0.10	0.14	-0.12	0.15	-0.12	0.17	-0.15	0.26
Change in Medicare ALOS	-0.13	0.10	-0.12	0.25	-0.16	0.32	-0.15	1.53
Monopolistic Competition	0.15	0.36	0.14	0.35	N/A	N/A	N/A	N/A
Some Monopolistic Competition	0.18	0.39	0.19	0.39	0.14	0.35	0.13	0.34
Oligopolistic	0.18	0.38	0.18	0.39	0.31	0.46	0.32	0.47
Duo/Monopoly	0.15	0.36	0.16	0.37	0.51	0.50	0.52	0.50
Change in Medicare Casemix	0.06	0.06	0.12	0.09	0.04	0.07	0.09	0.09
Change in Occupancy Rate	-0.11	0.15	-0.19	0.21	-0.13	0.28	-0.24	0.28
Medium Cost State	0.47	0.49	0.68	0.47	0.58	0.49	0.73	0.44
California	0.16	0.37	0.11	0.31	0.02	0.13	0.01	0.09
Low Cost State	0.07	0.25	0.04	0.20	0.20	0.40	0.13	0.34
Percent Medicare Discharges	0.34	0.12	0.34	0.12	0.42	0.12	0.42	0.11

Sources: Merged Medicare Cost Reports, Provider of Service File, and AHA Annual Survey data.

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increase over the TEFRA levels. By the third year of PPS, urban averages had increased 41 percent; rural averages, 45 percent over the TEFRA average costs. These increases were despite drops in both the overall and Medicare only average lengths of stay. Overall, the urban ALOS dropped ten percent in the first year of PPS and 12 percent by the third. Rural average lengths of stay in PPS-1 were 12 percent lower than those in TEFRA and 15 percent less in PPS-3. Decreases in Medicare stays were greater than for non-medicare stays in PPS-1 (13 percent for urban, 16 percent for rural hospitals) but averaged the same as non-Medicare by PPS-3, although with greater variance.

The figures for the market concentration categories represent the percentage of the hospitals in each type of market. Similarly, 47 percent of urban hospitals and 58 percent of rural ones were in medium-cost states (relative to the national TEFRA average), 16 and 2 percent were in high-cost California, and 7 and 20 percent were in relatively low-cost states. Hospitals' medicare casemix increased on average of six percent in urban areas for PPS-1 compared to TEFRA while rural indexes increased only four percent. By the third year of PPS the averages were twelve and nine percent respectively. The Medicare caseloads are defined for the hospitals 'TEFRA years and so do not change. Rural hospitals were more dependent than urban facilities on Medicare revenues in TEFRA.

Table 4-5 displays regression estimates explaining rates of change in the average cost per case between hospitals' TEFRA years and their first and third years under PPS. Separate regressions were estimated for urban and rural hospitals because the categories measuring seller concentration were so different between the two types of location. It is hypothesized that hospitals in the higher cost (lower concentration) markets would contain inflation more holding constant increases in the hospitals' mix of cases (measured by the Medicare casemix indexes in the analytic years). Changes in occupancy rates were also stepped into the regressions as were the hospitals' dependency on Medicare at the start of PPS (measured by the percentage of all discharges that were Medicare) and whether the hospital was in a high cost (including

TABLE 4-5

EXPLAINING CHANGE IN AVERAGE COST PER CASE BETWEEN TEFRA AND INDICATED YEAR

	HOSPITAL LOCATION AND FISCAL YEAR			
	Urban		Rural	
	PPS-1	PPS-3	PPS-1	PPS-3
Constant	0.13***	0.16***	0.21***	0.21*
Degree of Seller Concentration				
Considerable Monopolistic Competition	-0.02	0.05	N/A	N/A
Some Monopolistic Competition	-0.02	0.01	N/A	N/A
Oligopoly	-0.01	0.01	a	0.13
Duopoly	-0.01	0.02	0.01	0.23**
Monopoly	N/A	N/A	0.01	0.15
Hospital Cost Factors				
Change in Casemix	0.08	0.53***	a	0.65***
Change in Occupancy	-0.34***	-0.75***	-0.06***	-0.30***
Medicare Dependency in TEFRA	-0.16***	0.05	-0.30***	-0.15
California	-0.03	0.05	-0.08	0.34
Medium Cost States	a	0.01	0.02*	0.04
Low Cost States	0.01	0.02	-0.01	-0.02
R^2	.07	.15	.03	.04
F Value	12	23	8	8
N	1587	1303	1934	1645

[a] Less than 0.005.

***Significant at one percent level.
**Significant at five percent level.
*Significant at ten percent level.

Source: Merged Medicare Cost Reports, Provider of Service File, and AHA Annual Survey data.

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California), medium, or low cost state in the TEFRA year. The excluded category is all high cost states except California. These latter variables were held constant to see the extent to which they explained differences between market areas.

Only the last step of the regressions is presented in Table 4-5, because the coefficients are not markedly different from one step to the next. While the F statistics are significant, the R squares are low, indicating that the explanatory variables are significant as a group but do not explain much of the variation in changes that occurred in these three years. One reason for this may be the changes in wages and teaching activities that may have occurred during this time but which are excluded from the regressions. Other changes in state programs that are omitted here may also account for some of the variation. A third source of error would come from differences in the relative generosity of the PPS payment formula that would reduce cost containment incentives during this period.

Nevertheless, we reject the hypothesis that hospitals in less concentrated markets in either urban or rural areas held cost inflation below that in other markets in the first year of PPS. To argue that they did, but that the econometric result is due to the omitted variables of wages and teaching activity, is to argue that these hospitals had to increase wages or teaching programs enough to offset any other savings they may have made; that they had no choice in these matters in the first year of PPS. While this is theoretically possible in a model of hospital wages determined by long term union contracts and of teaching programs growing without bound, it is not plausible, especially over a longer time period. By the third year of PPS, there was still no significant difference in cost containment across types of urban markets, although, there was a weak relationship in rural markets with more concentrated markets showing greater increases, especially in duopolies.

Taking urban markets first, we find that by the first year under PPS, hospitals in markets with Herfindahl Indexes greater than .05 had experienced about the same amount of inflation as those in the least concentrated markets,

even when other factors were held constant. The coefficients for the four market categories are not significant but they are negative - indicating lower inflation in more concentrated markets on average, ceteris paribus, but not significantly lower.

The important hospital cost factors were changes in the hospitals' occupancy rates (a slower decrease in occupancy significantly reduced average costs) and the degree of dependency on Medicare at the start of PPS (the larger the proportion of Medicare discharges in TEFRA, the lower the hospital's percentage increase in costs).

For each additional percentage of TEFRA admissions that were covered by Medicare, urban hospitals held average cost increases 0.16 percentage prints below the overall urban average while rural hospitals held them 3 percentage points below average. Conversely, urban hospitals with declines in occupancy two times greater than the eleven percent urban average decline (or -.22 percent) is experienced cost increases of almost 13 percent compared to the 11 percent average urban inflation ceteris paribus. For rural hospitals, the same double decline in occupancy (2 * .13 = .26) would result in 15 percent cost inflation compared to the 11 percent rural average, ceteris paribus. Both occupancy changes and Medicare dependency are significant at the one percent confidence level for both urban and rural hospitals. Changes in the Medicare casemix index were associated with higher rates of increase in costs but the differences are not statistically significant for the PPS-1 year. This is inconsistent with an interpretation that much of the increase in the casemix index in the first year of PPS was due to upcoding medical records which occurred more in large urban hospitals treating the more severe cases to begin with. These changes did not contribute to cost inflation because only a small part of the change in the index could be attributed to a rural change in casemix severity.

Among the non-waivered states that had high standardized costs prior to PPS (whose hospitals could be expected to hold inflation at a lower level due to PPS's average cost price regulation), California had a lower rate of

increase between TEFRA and PPS-1 than did other high-cost states, but it was not statistically significant at even the ten percent level. Hospitals in medium- and low-cost states also did not experience statistically different rates of cost increase, either.

By the third year of PPS, while the average rate of cumulative inflation since TEFRA was 41 percent (see Table 4-4), the rate differed according to changes in hospitals' casemix and occupancy, not their market concentration, dependency on Medicare or level of costs in TEFRA. Specifically, cost inflation was a little higher in the more concentrated markets but not significantly so, nor in a way that is consistent with the differences in costs observed in Table 4-2. That is, hospitals in markets with indexes of concentration next to the lowest (.05 to .1) had a higher average, ceteris paribus, than those in the more concentrated markets.

By PPS-3, increases in the Medicare casemix index are highly correlated with increases in average costs per case. The value of .53 is significant at the one percent level. One explanation for this switch in the importance of the casemix index between the first and third years of PPS is that, in the first year, the casemix was changing due to improved casemix coding and was unrelated to real case severity. By the third year, the severity of the diagnoses treated on an inpatient basis had increased due to changes in admissions practices (treating less severe cases on an outpatient basis and not allowing social admissions, for example).

Changes in hospitals' occupancy rates had a greater impact on average costs in the third year of PPS than in the first. The coefficient value more than doubled and remains highly significant. One major reason for this may be that the first year decline in occupancy rates was due more to reductions in lengths of stay while the occupancy declines in PPS-2 and PPS-3 came more from declines in admissions. Table 4-4 showed that average lengths of stay (ALOS) declined very little overall in the second and third years of the program while the declines in occupancy almost doubled by PPS-3 compared to the drop in the first year of PPS. Average fixed costs are a signifigant part of our

cost measure. There are a number of costs that are fixed even across a three year period (interest and depreciation, in particular). These costs are spread over all days and discharges in calculating average total costs. Therefore a marginal decline in ALOS of even ten percent will have less of an impact on average total costs than would a ten percent decline in admissions.

Hospitals' Medicare dependency has become insignificant as an explainor of cost inflation by the third year. This suggests that the hospitals that acted most drastically in the 1984-85 fiscal years were those serving large Medicare populations but within just two years the changes in practices on the part of the providers was extended to most providers either due to changing standards or because other insurors were also exerting pressures to contain costs. The level of costs in TEFRA is likewise insignificant in explaining changes in costs between TEFRA and PPS-3, *ceteris paribus*. While the sign of the dummy variable for California has become positive, the higher average inflation (5 percentage points) is statistically insignificant.

The story for rural hospitals is similar in a number of respects. Differences in the rate of cost inflation between TEFRA and PPS-1 are highly correlated with changes in occupancy and the dependency of hospitals on Medicare in TEFRA. The more occupancy dropped, the greater the increase in average costs. While highly statistically significant, the level of the cost increase due to decreased occupancy was lower than that among urban hospitals (-.06 versus -.34). This might be in keeping with the low marginal costs associated with the days by which rural lengths of stay declined. On the other hand, the impact of having a heavy Medicare caseload was greater than in urban markets (-.30 versus -.16), in part due to the greater average dependency in rural areas to begin with.

Rural market concentration was unimportant in explaining cost increases in PPS-1 as was the relative level of rural costs prior to prospective payment. Rural California hospitals had an insignificantly lower rate of cost inflation than those in other high-cost states. Medium-cost state hospitals experienced higher inflation rates than did high-cost states but the

difference was significant at only the ten percent confidence level.

By the third year of PPS, the relative differences in costs under TEFRA are not statistically significant in accounting for hospital cost inflation post-PPS. Neither is each hospital's dependency on Medicare in TEFRA. Changes in occupancy and casemix are highly significant and have a sizeable impact on average costs. The coefficient of the Medicare casemix index, especially, has approached the level for the regressions in Table 4-3. The least concentrated rural markets did not hold inflation down more than hospitals in other markets except for duopolies (HI between .5 and 1). However, the mean increases for the other concentrated markets are positive but insignificant.

For urban hospital markets, therefore, there is no evidence that the high costs associated with less concentration led to lower rates of inflation in the first three years of PPS. Table 4-5 presents the results controlling for initially high levels of costs in the state but the same result obtained without this factor included (not shown here). Analyses for the years beyond PPS-3 may find a significant impact. For rural hospitals, there is somewhat more evidence (that market concentration may indeed be related to cost containment). While not significant in PPS-1, by the third year of the program, more concentrated markets were experiencing higher inflation, controlling for changes in occupancy rates.

In the first year of PPS, hospitals that were more dependent on Medicare revenues (whether urban or rural) held their cost inflation below that of hospitals with lower dependence on Medicare. In addition, hospitals that suffered a drop in inpatient utilization also experienced higher cost inflation. This effect intensified during the next two years of PPS while the effect of Medicare dependency did not. This may be due to an initial flurry of activity due to uncertainty over the effects of PPS which disappeared.

Increases in the Medicare casemix (a proxy for the severity of all inpatient cases treated in the hospital) had a markedly increased effect on average costs over the first three years of PPS. This undoubtedly reflects

differences in coding between the first and third years of the program. By the third year, increases in the index were due to increased severity of cases treated rather than merely upcoding of records.

The coefficients for relative costs standardized for relative wages, teaching and casemix across states suggest that the costs of treatment in these states will not converge at any time in the near future. The differences were not significant statistically but they were also not large rates of change. That is, a one or two percent difference in inflation between states with hundreds of dollars difference in the level of costs will not result in identical standardized costs in the next ten or twenty years.

4.2.2 The Relationship of Market Concentration to Changes in Lengths of Stay

One way in which higher-cost hospitals can control cost increases is to reduce average lengths of inpatient stay. While the costs of a marginal inpatient day may be small if the additional time is medically unnecessary, reducing the time in the hospital was one of the simplest responses to the revenue constraints of PPS. In addition, other evidence indicates that hospitals did indeed reduce lengths of stay markedly in the first year or two of PPS; our question here is whether this was related to higher average costs associated with hospitals' location in markets with more rivals.

Urban and rural hospitals in markets with different degrees of seller concentration generally did not exhibit significantly different rates of cost increase in the analyses above. Did they also reduce average lengths of stay the same amount? Tables 4-6 and 4-7 indicate that the answer to this question is both yes and no.

Table 4-6 presents regressions of the change in the average length of stay for all inpatient discharges between TEFRA and either the first or the third year of PPS on the same explanatory variables used to test for significant differences in average costs per case in Table 4-5. An exception is that the change in the hospital's occupancy rate is not included in 4-6 as

TABLE 4-6

CHANGE IN AVERAGE LENGTH OF STAY, ALL DISCHARGES

	URBAN		RURAL	
	TEFRA to PPS-1	TEFRA to PPS-3	TEFRA to PPS-1	TEFRA to PPS-3
Constant[a]	-0.04***	-0.10***	0.05***	-0.06
Degree of Seller Concentration[b]				
Monopolistic Competition	0.01	-0.01	N/A	N/A
Some Monopolistic Competition	0.01**	-0.01	N/A	N/A
Oligopolistic	0.01***	-0.01	c	0.02
Monopoly/Oligopoly	0.02**	-0.02	c	0.07*
Monopoly			0.02	0.05
Hospital Cost Factors				
Change in Casemix	0.02***	0.14***	-0.06	0.23***
Medicare Dependency in TEFRA	-0.17***	-0.13***	-0.45***	-0.44***
California	0.02	0.03**	-0.05*	0.07
Medium Cost State	b	-0.01	0.01	0.03**
Low Cost State	0.02	-0.01	0.02	0.02
R-Square	.03	.02	.11	.05
F Value	6	4	33	12
N	1918	1551	2210	1888

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[a] The dependent variable is the percentage change in the average length of stay for all inpatients, not including stays in swing beds.

[b] Degrees of urban seller concentration are defined as:
Monopolistic competition: HI = .05-.10.
Some monopolistic competition: HI = .1-.18.
Oligopolistic: HI = .18-.3.
Monopoly/Oligopoly = .3-1.0.
The least concentrated (HI < .05) are in the constant.

[c] Less than 0.005

[d] Hospitals in ten states with average standardized costs per case of $2600 or more in TEFRA, other than California (which had the highest average) are in the constant.

"Low cost state" indicates location in nine states with state average standardized cost below $2,200 in TEFRA.

"Medium cost state" identifies those with costs between $2,200 and $2,600.

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an explanatory variable, because that change is caused by changes in the length of stay, not vice versa. These variables explained more of the variation in changes in the lengths of stays in rural hospitals than in urban ones, although the F statistics were highly significant (at the .01 level or better) for both sets of regression estimates.

In the first year of PPS, urban hospitals in the less concentrated markets reduced their lengths of stay significantly more (one to two percent greater reductions) than did hospitals in markets that were oligopolistic or monopolistic (those with Herfindahl Indexes greater than 0.10). This indicates a reduction of 11 or 12 percent versus the 9-10 percent in the least concentrated markets. In addition, increases in the severity of the mix of cases led to small but highly significant increases in the average length of stay.

Finally, the extent to which the hospitals were dependent on Medicare discharges prior to PPS had a highly significant impact on overall lengths of stay. The greater the percentage of discharges in TEFRA that were covered by Medicare, the greater the hospital's reduction in total lengths of stay. For example, an urban hospital with 44 percent Medicare patients would have reduced ALOS by 13 rather than 11 percent. The reductions in stays for all inpatients do not appear to be correlated to the states' relative standardized costs in TEFRA. The differences in reductions in average lengths of stay were not significant for high cost states (the excluded category) and California (the highest cost state) or either of the other two groups.

While Table 4-6 presents the regression results with all the explanatory variables included, additional regressions in which each group of independent measures was stepped into the model separately (not shown here for the sake of brevity) are consistent with the results presented here. In the first year of PPS, hospitals in the least concentrated urban markets reduced their lengths of stay a small but statistically significant amount more (in percentage terms) than did hospitals with few rivals, holding constant the change in casemix severity in the same period and each hospital's Medicare caseload at the start of prospective payment.

By the third year of PPS, however, market concentration was not important in explaining reductions in overall lengths of stay for urban hospitals in non-waivered states. Increases in the severity of the cases and the hospitals' dependency on Medicare remained highly significant, however, as explainors of changes in average lengths of stay. Stays increased in length as the Medicare casemix index increased, indicating more severe cases being treated in the hospital, on average. In addition, the greater the proportion of Medicare cases handled in the hospital, the greater the decrease in the average stay. Finally, California's urban hospitals appear to have a smaller decline in stays than did their counterparts in other high-cost states. However, location in a low or medium cost state did not lead to a significantly different level of reduction in lengths of stay, indicating that this measure of the bite of PPS had little effect on urban stays.

The main result shown in Table 4-6, that seller concentration is related to reduction in the average length of stay only in the short run, may be consistent with the unimportance of urban market concentration in explaining reductions in costs post-PPS that is shown in Table 4-5. Hospitals in large urban markets may have reduced inpatient stays somewhat more, ceteris paribus, in the first year of PPS and achieved the same percentage reduction in costs as did hospitals in medium and small metropolitan areas. After three years, hospitals in all markets had achieved approximately the same reductions, accounting for their changes in casemix.

For rural hospitals in the first year of PPS, in contrast, market concentration made no difference in explaining the change in the average length of stay for all inpatients. By the third year of the program, however, the more concentrated markets were experiencing lower decreases or perhaps small increases in stays, even controlling for casemix and their Medicare caseloads. This mirrors the finding in Table 4-5 that rural duopolies (Herfindahls between .5 and 1) had greater cost inflation over the first three years of PPS than did other rural markets. Table 4-6 suggests that this was due in part to a smaller decline in stays over and above the increase associated with increases in the severity of caseloads.

The hospitals' dependency on Medicare (as measured by the percentage of all discharges covered by Medicare) was a highly significant predictor of decreased lengths of stay for rural hospitals in both the first and third years of prospective payment. The greater the percentage of all discharges that were Medicare patients, the greater the decrease in average stays in the hospital. In the third year, the increased casemix severity was also highly significant as a predictor of increased hospital lengths of stay.

In the first year of PPS, the average percentage decreases in Medicare lengths of stay for both urban and rural hospitals were only a little greater than the overall decreases in the first year of PPS (13 versus 10 percent for urban hospitals, 16 versus 13 percent for rurals, Table 4-4). By the third year, the average percentages for Medicare and total discharges are the same (12 percent for urban hospitals, 15 percent for rurals). Table 4-7 presents regression estimates for the changes in the average lengths of stay for urban and rural Medicare discharges. The hypothesis assessed here is whether the degree of seller concentration led to a significantly greater reduction in Medicare lengths of stay, holding constant hospital-specific dependency on Medicare on the eve of PPS and changes in the Medicare casemix. A state-level dummy variable also holds constant whether the hospitals were in high- or low-cost states.

Table 4-7 shows that in urban markets in the first year of PPS, hospitals in oligopolistic and monopolistic markets did not reduce their Medicare lengths of stay as much as those in less concentrated markets. This was not true for rural hospitals in PPS-1 nor was it true for either group by the third year of PPS. Of the other explanatory variables, only the change in Medicare casemix indexes was a significant explainor, and that only for urban hospitals. In combination with the results in Table 4-6, this suggests that hospitals in all markets reduced their Medicare stays by similar percentages, regardless of how many Medicare patients they had. However, the more dependent they were on Medicare revenues, the greater the reductions in stays for the overall average of the hospital, especially rural hospitals. In urban

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TABLE 4-7

CHANGE IN AVERAGE LENGTH OF STAY, MEDICARE DISCHARGES ONLY

	URBAN		RURAL	
	TEFRA to PPS-1	TEFRA to PPS-3	TEFRA to PPS-1	TEFRA to PPS-3
Constant[a]	-0.15***	-0.16***	-0.14***	-0.18
Degree of Seller Concentration[b]				
Monopolistic Competition	0.01	-0.03	N/A	N/A
Some Monopolistic Competition	0.02**	-0.02	N/A	N/A
Oligopolistic	0.02***	-0.01	0.01	b
Monopoly/Oligopoly	0.02**	-0.02	0.03	0.13
Monopoly			0.02	0.01
Hospital Cost Factors				
Change in Casemix	0.16***	0.21***	-0.02	0.65
Medicare Dependency in TEFRA	-0.02	0.01	-0.05	-0.18
California	0.02	0.04*	0.01	0.05
Medium Cost State	-0.01	0.03	-0.03*	0.01
Low Cost State	0.02	0.03	-0.02	-0.03
R-Square	.02	.01	.003	.003
F Value	5	1	1	1
N	1918	1551	2210	1888

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[a] The dependent variable is the percentage change in the average length of stay for all inpatients, not including stays in swing beds.

[b] Degrees of urban seller concentration are defined as:
Monopolistic competition: HI = .05-.10.
Some monopolistic competition: HI = .1-.18.
Oligopolistic: HI = .18-.3.
Monopoly/Oligopoly = .3-1.0.
The least concentrated (HI < .05) are in the constant.

[c] Less than 0.005

[d] Hospitals in ten states with average standardized costs per case of $2600 or more in TEFRA, other than California (which had the highest average) are in the constant.

"Low cost state" indicates location in nine states with state average standardized cost below $2,200 in TEFRA.

"Medium cost state" identifies those with costs between $2,200 and $2,600.

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markets with ten or more hospitals, the initial reductions in stays for both Medicare and all patients were greater than those in other areas, holding constant the increased stays due to increased severity of cases.

4.2.3 The Relationship of Market Concentration to Hospitals' Finances from TEFRA Through PPS-3

One measure of hospital performance that has received considerable attention has been their net revenues. These were announced as being the highest in recent history for the first federal fiscal year of prospective payment. However, they have been reported by hospitals to have been falling drastically since then. This section examines the evidence that these net revenues were higher in monopoly markets (which tended to be the lower cost markets on the eve of PPS, holding constant casemix, etc.). For this analysis, both urban and rural hospitals were divided into three groups according to their ownership. Differences in net operating revenues were examined within these groups rather than across them. Ownership is so important in explaining the level of net operating revenues that its effects must be seperated from those across time.

Government hospitals tend not to break even on operations because many of them receive large subsidies from their government units for the care of the indigent or for general operations. Proprietary hospitals receive virtually no such non-operating revenues but must earn profits on their operations alone. For many private voluntary facilities, philanthropic contributions are a major source of non-operating revenues. However, these revenues are not guaranteed so the hospitals must be prepared to at least break even on their operations alone.

The importance of ownership to the levels of net hospital revenues is demonstrated in Table 4-8, which presents the ratios of operating and total revenues to the appropriate costs for six categories of hospitals for TEFRA and the first three years of prospective payment. These accounting profits or

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TABLE 4-8

RATIOS OF REVENUES TO COSTS BY FISCAL YEAR FOR OWNERSHIP CATEGORIES OF URBAN AND RURAL HOSPITALS

Ownership and Location	TEFRA	PPS-1	PPS-2	PPS-3
Voluntary				
Urban (Number of hospitals)	(369)	(1178)	(1175)	(991)
Operating Revenues/costs	1.02	1.05	1.03	1.01
Total Revenues/costs	1.05	1.09	1.07	1.05
Rural (Number of hospitals)	(308)	(990)	(981)	(849)
Operating Revenue/costs	1.00	1.02	1.00	0.98
Total Revenues/costs	1.05	1.07	1.05	1.03
Proprietary				
Urban (Number of hospitals)	(160)	(407)	(399)	(302)
Operating Revenues/costs	1.07	1.09	1.08	1.03
Total Revenues/costs	1.06	1.10	1.08	1.04
Rural (Number of hospitals)	(58)	(227)	(231)	(181)
Operating Revenue/costs	1.06	1.03	1.03	0.97
Total Revenues/costs	1.05	1.05	1.05	0.99
Local/State Government				
Urban (Number of hospitals)	(69)	(293)	(289)	(242)
Operating Revenues/costs	0.99	0.98	0.98	0.96
Total Revenues/costs	1.06	1.07	1.06	1.04
Rural (Number of hospitals)	(276)	(978)	(971)	(854)
Operating Revenue/costs	0.93	0.97	0.94	0.92
Total Revenues/costs	1.02	1.07	1.03	1.01

Source: Merged Medicare Cost Reports and AHA Annual Survey data.

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losses were calculated in this manner to minimize the effect of legitimate outliers on the mean values. Case studies confirmed that large values for losses in particular (e.g., a hospital collecting 25 percent of operating costs) were possible and these tend to skew the distribution if they are expressed as the ratio of net revenues (total revenues minus costs) to costs.

The number of observations for each fiscal year are given in parentheses. The numbers for the hospitals' TEFRA years are about a third of those for the first two years of PPS because of incomplete Medicare Cost Report data. The numbers for PPS-3 are also a little lower because those hospitals whose 1987 fiscal years were their third under prospective payment had not yet filed the reports with Medicare when this database was constructed. Nevertheless, the numbers in all but two of the ownership-fiscal year cells are sufficiently large for an examination of the effects of market concentration on net revenues.

The picture of both operating and total revenue to cost ratios over the four fiscal years is very similar for all six categories of hospitals by location and ownership. Whatever the level in TEFRA, it increased in the first year of prospective payment and then fell over the next two years. For example, urban private voluntary hospitals collected five percent more than their total costs under TEFRA, increased this excess to nine percent in PPS-1 and saw it decline to five percent again by the third year of the program. The decline between the second and third years of PPS was most marked for proprietary hospitals.

Another similarity within ownership categories is that rural hospitals consistently performed worse financially than urban ones for both operating and total margins. On average, urban and rural voluntary hospitals broke even on their operations in all but the third year of PPS, when the rural hospitals collected only 98 percent of their operating costs. The rural voluntary hospitals did not collect as much of their costs as urban voluntary hospitals did in any of the years, however. Both urban and rural facilities collected an additional four or five percent as non-operating revenues, however, in each

of the four years. This means that the average margin on total costs was five percent or better for all years, except for volunatry rural hospitals in PPS-3. While the first year under prospective payment saw margins that were 40 to 80 percent higher than those in TEFRA, the increase was not more than two percentage points above the earlier year. Similarly, the declines have been two percent in each of the succeeding years.

Proprietary hospitals show higher operating margins than voluntary hospitals but once the latter's charitable contributions are taken into account, the ratios of total revenues to costs are very similar between the two groups. The declines for rural hospitals between TEFRA and PPS-1 may be attributable to the small number of reports in TEFRA.

Hospitals owned by local and state governments did not breakeven on operations in any of the four years but earned total margins only a little lower than the other groups. The size of the nonoperating revenues are large relative to these hospitals budgets (especially in rural areas) but it should be borne in mind that these facilities are generally small hospitals and the subsidies may be less than $100,000 compared to urban voluntary hospitals with budgets of hundreds of millions of dollars where a smaller percentage represents far greater absolute dollars amounts.

Across all six categories, only the rural proprietary hospitals were failing to cover their total costs on average in any year. All of the other groups were earning at their TEFRA levels or a little below in the third year of PPS, following two years of additional marginal revenues.

How did these margins relate to market structure? Multivariate regressions were estimated to test for significant differences in the ratios of operating revenues to operating costs across the six ownership categories within each of the four years. Returns on operations were used because we did not want to measure the correlation between market concentration and subsidies or charitable giving. Table 4-9 summarizes the statistically significant results of the 24 sets of regressions by listing the F statistic, the explanatory variables that were significant at the ten percent level or

TABLE 4-9

SUMMARY OF REGRESSIONS EXPLAINING RATIOS OF OPERATING REVENUE TO COST BY OWNERSHIP BY FISCAL YEAR

	HOSPITAL FISCAL YEAR			
	TEFRA	PPS-1	PPS-2	PPS-3
URBAN HOSPITALS				
Private Voluntary	F=1 Low Cost State (+,***)	F=4 Low Cost State (-,**); Chg. ALOS (-,**); Chg. Occ. Rate (+,***) Percent Medicare Discharge (+,**)	F=5 Chg. ALOS (-,**) Chg. Occ. Rate (+,***) Percent Medicare Discharge (+,**)	F=4 Low Cost State (+,**) Seller Concentration (+,*) Chg ALOS (-,*) Chg. Occ. Rate (+,***) Percent Medicare Discharge (+,*)
Proprietary	F=1	F=2	F=3 Chg. Occ Rate (+,***) Percent Medicare Discharge (-,**)	F=2 Calif. (-,**) Chg. Occ. Rate (+,***)
Local/State Government	F=1	F=5 Low Cost State (+,**) Chg. Occ. Rate (+,**) Percent Medicare Discharge (+,***)	F=2 Low Rel. State Cost (+,***) Chg. ALOS (-,**) Percent Medicare Discharge (+,***)	F=6 Low cost State (+,***) Percent Medicare Discharge (+,***)
RURAL HOSPITALS				
Private Voluntary	F=4 Seller Concentration (+,**) Percent Medicare Discharge (-,*)	F=5 Seller Concentration (-,*) Percent Medicare Discharge (-,***)	F=8 Low Cost State (+,***) Chg. ALOS (+,***) Chg. Occ. Rate (+,***) Percent Medicare Discharge (-,***)	F=8 Low Cost State (+,***) Chg. Occ. Rate (+,***) Percent Medicare Discharge (-,***)
Proprietary	F=1	F=3 Chg. Occ. Rate (+,***) Percent Medicare Discharge (-,*)	F=3 Chg. Occ. Rate (+,***) Percent Medicare Discharge (-,*)	F=2 Low Cost State (+,*) Percent Medicare Discharge (-,**)
Local/State Government	F=1	F=8 Low Rel. State Av. Cost (+,***) Chg. Occ. Rate (+,***)	F=2 Low Rel. State Av. Cost (+,**) Chg. Occ. Rate (+,**)	F=8 Low Cost State (+,***) Chg. ALOS (-,***) Chg. Occ. Rate (+,***)

Source: Merged Medicare Cost Reports and AHA Annual Survey data EXK833121488

better, and (in parentheses) the direction of each variable's influence on the ratio of operating revenues to costs and the level of statistical significance (* indicates the ten percent confidence level; ***, the one percent level). The coefficient values are not given here because their size is very sensitive to the regression specification and it is not appropriate to attribute specific amounts of profits or loss to any factor.

The independent variables included the same market concentration categories as those used in the regressions discussed above (see Tables 4-2 and 4-3), the percent of the hospitals' discharges that were covered by Medicare, whether the hospital was in a low relative cost state, and (for the PPS years) the percentage change in occupancy rate and average length of stays (the two behavioral factors that we could measure that should directly affect operating costs and thus profits). With respect to the independent variables other than seller concentration, they are factors that are expected to affect the level of average costs and therefore profit margins with the exception of Medicare dependency which tests whether, on average, Medicare caseload was correlated with favorable or unfavorable financial positions.

A priori, one might expect that seller concentration would not be related to financial performance for government hospitals because they are heavily subsidized and might be expected to have a political mandate to keep rates low for the community they serve. Proprietary hospitals are expected to exploit market power because of the financial incentives to perform. For private voluntary hospitals, expectations are mixed. On the one hand, these hospitals have many other goals to meet so that they might merely satisfies with respect to profits and concentrate on their other missions. On the other hand, this category includes some of the largest and most prestigious institutions in the country and, as one executive put it: "No margin, no mission." Therefore, we might indeed expect these institutions to exploit any market power available to them through monopoly positions.

Five of the cells in Table 4-9 had insignificant (at even the 10 percent level) F statistics of two or less. The other F values were significant at

the ten percent level or better. Seller concentration was a significant variable for three of the sets of regressions: rural private voluntary hospitals in TEFRA and PPS-1 and urban private voluntary hospitals in the third year of PPS. In the first and third of these instances, a greater degree of monopoly power was associated with higher ratios of revenues to costs. For rural voluntary hospitals in the first year of PPS, however, the effect of having a monopoly was to reduce the ratios. Overall, this is not strong support for the hypothesis that market concentration facilitates higher profits in the private voluntary hospital sector. The hypothesis that proprietary hospitals would capitalize on monopoly positions received no support in these regressions.

Among the other explanatory variables, location in a low-cost state tended to raise margins, and in the three PPS years, lowering lengths of stay and having a smaller decline in occupancy rates was associated with higher ratios of revenues to costs. Both of these behaviors have already been shown to have decreased costs. The levels of significance are generally at either the five or one percent levels.

The percentage of all discharges that was covered by Medicare was correlated with revenue to cost ratios for both urban and rural hospitals but the effects were the opposite for the two groups. For urban hospitals, higher caseloads of Medicare patients were correlated with higher revenue/cost margins except for urban proprietary hospitals for which there was either no correlation or a negative one in PPS-2. For voluntary and proprietary rural hospitals, having more Medicare inpatients was associated with lower revenue ratios. The relationship was present for all four years for rural private voluntary hospitals and was highly significant. For rural proprietary hospitals, the relationship was consistent across the years but was significant at only the five or ten percent level. For rural government hospitals, there was no statistically significant relationship.

In conclusion, the somewhat higher costs in the less concentrated urban and rural hospital markets do not seem to translate into lower profit margins.

The behaviors of shortening stays and preventing a large decline in occupancy did pay off in higher bottom lines for the hospitals. Medicare caseloads were positively correlated with profits in urban areas but negatively correlated in some rural markets, suggesting that the payment algorithm may have favored urban hospitals during this time.

4.3 Did Hospital Market Concentration Change Under PPS?

Section 3 showed that during the 1980s there have been exits and entries to acute-care hospital markets. Section 4.1 presented evidence that the degree of concentration in hospital markets is associated with the level of relative costs although the threshold for this is considerably lower in rural markets than in urban ones. Has PPS contributed to any changes toward more or less concentration in acute-care markets?

4.3.1 Changes in the Numbers of Exits and Entries

The database for this project does not include sufficient post-PPS data to support conclusive answers to the above question. Table 4-10 shows that the number of closures and changes from acute-care status increased in 1984 and 1985 compared to the pre-PPS period. Total exits averaged 33.7 per year for 1981 through 1983 and almost doubled to 60.5 per year for 1984 and 1985. However, can major decisions like these be attributed to a program that had just begun and that may not have affected the payments of the hospitals in question during 1984 because of the timing of their fiscal years? (That is hospitals closing in 1984 could still have been covered by TEFRA regulations.) While the rate of closures also increased during this time in the waivered states the increase was marginal from five to six per annum.

Some other reasons for increased numbers of closures include the technological changes that contributed to a shift of many patients to an outpatient treatment setting, stricter policies of private insurers, and

financial crises of local and state governments that may have led them to stop funding underutilized facilities that they owned. Without a long pre-PPS database, it is impossible to separate long-run trends in markets from the changes of the 1980s.

Table 4-10 also shows that openings continued apace through 1985, the latest year for which reliable counts were ascertained. Many of these occurred in markets in which there had previously been a closing, indicating that for some, PPS was not a barrier. In fact, verifying actual closures and openings from state agencies and association, we learned that some of these openings were possible only because the closures had occurred, freeing up liscensed beds or otherwise clearing the way for the entry.

The rate of entry decreased slightly from an average of 18.3 openings per year to 17 in each of the two post-PPS years for which complete information is available. If the 1986 figure of five entries in total is accurate, the drop is more precipitate, however. The conclusion would be that the changes of the 1980s led to far slower rates of entry but only with a lag.

Nineteen metropolitan areas and four rural counties had both entries and exits during the 1980s. Four of the MSAs were in northern states: Pennsylvania, Michigan, Minnesota and Washington. Two of the rural counties were in Minnesota and Oregon. Fifteen MSAs and two rural areas were in the South and Southwest. Ten of the areas were in the two states of Texas and Louisiana. However, Los Angeles California was the most active market with 23 exits and five entries during this period, of which eight exits and two entries occurred in the two years post-PPS (1984 and 1985).

Below, we explore further the evidence that PPS is affecting the market structures of the hospital industry. The evidence is the numbers of beds gained and lost during the 1980s, the relative market shares of hospitals that closed before and after PPS, the changes in the Herfindahl Indexes of market concentration in markets where exits and entrances occurred and a summary of the effect on markets that lost their monopoly hospitals.

TABLE 4-10

EXITS AND ENTRIES OF ACUTE-CARE HOSPITALS BY YEAR, NON-WAIVERED/WAIVERED STATES*

	NON-WAIVERED			
	EXITS		ENTRIES	
Year	Closures	Change from Acute-Care	Openings	Change to Acute-Care
1980	26	b	1	b
1981	29	2	20	3
1982	27	8	9	1
1983	32	3	22	0
1984	57	4	15	0
1985	57	3	19	0
1986	a	3	4	1
TOTALS	228	23	89	5

	WAIVERED			
	EXITS		ENTRIES	
Year	Closures	Change from Acute-Care	Openings	Change to Acute-Care
1980	5	0	0	0
1981	3	0	0	0
1982	7	1	0	0
1983	4	0	0	0
1984	5	1	0	0
1985	6	0	0	0
1986	a	0	0	0
TOTALS	30	2	0	0

*Excluding Alaska and Hawaii.

[a] Data on closures in 1986 not available at time of writing.
[b] Mergers and other changes could not be identified.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File
KLR297/81088

4.3.2 Changes in Bed Capacity

Table 4-11 (reproduced from Hendricks, et al., 1988) shows the total changes in acute-care beds for the non-waivered states for each year from 1980 through 1986. The count does not include beds lost due to mergers or changes from acute-care status in 1980 or hospital closures in 1986. It also omits any gains in capacity from specialty hospitals becoming acute-care facilities in 1980. Additional years of data are required to distinguish industry changes in these years from omissions due to non-reporting.

This table summarizes the changes in acute-care capacity for the non-waivered states, excluding Alaska and Hawaii. They are divided into the pre-PPS changes (1980-1983) and post-PPS ones (1984-86). The first column indicates how many acute-care beds were contained in all the acute-care hospitals that closed each year. That is, in 1980, closures accounted for a reduction of 2,365 beds. In that same year, one hospital with 100 beds opened. The net change in bed capacity was a reduction of 2,265 beds, which represented 0.3 percent of the total beds in that year.

Over the next three years, hospital openings added 319 more beds to the industry than closures took away. There were only 51 of the former and 88 of the latter. The average bedsize of a new hospital was 94; of one that closed, 60 beds. Therefore, closing hospitals were smaller than those that opened, pre-PPS.

Other changes did not affect total capacity very much, except for the change of one 916-bed hospital to non-acute care in 1982. Therefore, taken all together, total industry capacity grew or shrank by less than 1,000 beds (sixth column) in each of these years, representing changes of only about 0.1 percent either way for 1981-83. At the same time the total number of staffed beds being reported by the hospitals grew 0.6 percent in 1981 and again in 1982, and 0.4 percent in 1983. These growth rates reflect the fact that expansion of existing hospitals' capacity in these years was greater than the reductions due to net decreases in the number of facilities.

The expansion of total industry capacity was most rapid during the first

TABLE 4-11

CHANGES IN ACUTE-CARE BEDS FROM HOSPITALS' ENTRIES AND EXITS PRE/POST PPS, NON-WAIVERED STATES*

	NUMBER OF BEDS GAINED (+) OR LOST (-) DUE TO:								
	Closures	Openings	Mergers	Change to Acute-Care	Change from Acute-Care	Total Change Due to Status Changes	Total Beds[a]	Percent Change in Beds Due to Status Change[b]	Total Percent Change in Beds
1980	-2,365	+100	d	d	d	-2,265	806,693	-.3%	----
1981	-1,263	+2,072	-66	+230	-129	+844	811,642	+.1	+.6%
1982	-1,222	+1,098	-7	+67	-916	-980	816,865	-.1	+.6
1983	-1,980	+1,614	-168	+65	-229	-698	820,408	-.1	+.4
Pre-PPS Subtotal	-6,830	+4,884	-241	+362	-1,274	-3,099	----	----	----
1984	-2,172	+1,134	-135	0	-332	-1,505	830,212	-.2	+1.2
1985	-2,802	+1,996	-57	0	-153	-1,016	804,254	-.1	-3.1
1986	c	+454	-587	+54	-324	-403	776,218	c	-3.5
Post-PPS Subtotal	-4,974	+3,584	-779	+54	-809	-2,924	----	----	----

*Excluding Alaska and Hawaii.

[a] This number represents all the beds in the year designated by the row.
[b] As percent of designated year. Other changes in beds (e.g., due to expansions) not included.
[c] Data on closures in 1986 not available at time of writing.
[d] Our database did not include the information necessary to identify 1980 mergers or 1980 service changes.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.
KLR297/81088
KLR449/82488

year of prospective payment. Total beds grew from 820,408 to 830,212, a 1.2 percent increase. This occurred despite a 0.2 percent decrease in beds occasioned primarily by the doubling of the number of closures (from 32 to 57). These closures accounted for 2,172 beds, an average of 38 beds per hospital. The fifteen openings in 1984 added 1,134 beds (76 a piece), while mergers and other changes took away 467.

From this 1984 maximum, industry capacity shrank 3.1 percent in the next year to the lowest number of beds since the 1970s. Only four percent of this reduction in staffed beds (1,016 beds) was the net result of reductions in the number of hospitals. The other 25,000 beds were simply not stuffed or closed, an average of only five or six per acute-care facility. The percentage decline between 1985 and 1986 was even greater but of the 3.5 percent drop in industry capacity the amount due to closures is unknown. However, interviews with hospital executives suggest that the 776,000 reported staffed beds may significantly overstate capacity. Hospital administrators fear that if their licensed beds are reduced they will be in weaker positions to respond to their competitors when the market environment changes. By preserving their licensed capacity, they hope to give themselves greater flexibility to create specialty units, to absorb the patient volumes from neighbors that fail or avoid any regulatory delays that might limit them. Executives estimate that the proportions of overreporting of staffed beds are greater for small hospitals but that all sizes of hospitals do it.

The numbers of beds gained and lost in any one year represent a tiny fraction of the national total (three or four thousand out of eight hundred thousand). They are also only a fraction of the changes in total capacity in any given year and their relative significance to other changes in total beds declines after PPS. That is, compared to the three percent decrease in the total number of acute-care beds in the non-waivered sates in 1984 and 1985, the 0.1 percent net decrease from hospitals leaving their markets is very small.

Table 4-12 presents similar bed figures for the four waivered states over the same period. Here, also, the changes due to exits are small compared

TABLE 4-12

CHANGES IN ACUTE-CARE BEDS FROM HOSPITALS' ENTRIES AND EXITS PRE/POST PPS, WAIVERED STATES*

	NUMBER OF BEDS GAINED (+) OR LOST (-) DUE TO:								
	Closures	Openings	Mergers	Change to Acute-Care	Change from Acute-Care	Total Change Due to Status Changes	Total Beds[a]	Percent Change in Beds Due to Status Change[b]	Total Percent Change in Beds
1980	-765	0	d	d	d	-765	146,077	-.5%	----
1981	-217	0	+82	0	0	-135	145,286	-.1	-.5%
1982	-939	0	0	0	-108	-1,407	145,205	-.7	-.1
1983	-240	0	+2	+108	0	-130	144,289	-.1	-.6
Pre-PPS Subtotal	-2,161	0	+84	+108	-108	2,317	----	----	----
1984	-638	0	0	0	-203	-841	152,671	-.5	+5.8
1985	-688	0	-126	0	0	-814	143,484	-.6	-6.0
1986	c	0	-213	+95	0	-118	139,009	-.1	-3.1
Post-PPS Subtotal	-1,326	0	-339	+95	-203	-1043	----	----	----

*Excluding Alaska and Hawaii.

[a] This number represents all the beds in the year designated by the row.
[b] As percent of designated year. Other changes in beds (e.g., due to expansions) not included.
[c] Data on closures in 1986 not available at time of writing.
[d] Our database did not include the information necessary to identify 1980 mergers or 1980 service changes.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File
KLR297/81088
KLR449/82488

to the net reductions in all bed capacity for that time. Thus, the loss of beds from hospitals exiting their markets had a minor impact on industry capacity, post-PPS, compared to the loss of beds reported overall (after an increase between 1983 and 1984) which did indeed increase in the post-PPS era.

However, this overall reduction in the bedsize capacity of hospital markets, if it is relatively uniform across facilities or at least across markets, will affect the concentration of the markets almost not at all, while the exit and entrance of acute-care facilities may drastically alter the structure of those individual markets. Table 4-13 presents the average market share of hospitals that closed pre- and post-PPS. In the non-waivered states, the average hospital closure was larger relative to its market after PPS compared to the pre-1984 period. The average pre-PPS urban closure in non-waivered states comprised only five percent of its market's capacity before it closed while post-PPS it was seven percent.

Rural closures in non-waivered states were larger compared to their markets, but that also grew in 1984 and 1985: from a 35 percent market share to 45 percent. In the waivered states, while urban closures were smaller relative to their markets post-PPS, the relative size of rural closures grew from only 12 percent to 29 percent of their counties' total hospital beds. This supports the contention that closures after the advent of PPS are concentrating rural markets more. However it must be borne in mind that in a number of markets (19 urban, 4 rural) this trend is offset by entries of larger hospitals.

One type of market of particular concern is that of markets left with no access to a local acute-care hospital. Rural closures between 1980 and 1985 represent only 4 percent of 1980 rural hospitals and less than 2 percent of all rural acute-care beds. Monopoly hospitals were almost one-fourth of these, representing one percent of all 1980 rural hospitals, but only 0.2 percent of rural beds and an even smaller proportion of the total industry's capacity.

Monopoly hospital closures are smaller in size than other rural hospitals (Hendricks, Dresser, et al., 1988). Rural hospitals had 75 beds, on

TABLE 4-13

AVERAGE MARKET SHARE OF HOSPITALS THAT CLOSE, ALL STATES, 1980-1985*

	NON-WAIVERED STATES	
	PRE - PPS	POST - PPS
Average Market Share		
Urban	5%	7%
Rural	35%	45%

	WAIVERED STATES	
	PRE - PPS	POST - PPS
Average Market Share		
Urban	6%	3%
Rural	12%	29%

*Excluding Alaska and Hawaii.

Source: Merged AHA Annual Surveys, Medicare Cost Reports, Provider of Service File.

KLR656/100188

average in 1983. Closing monopoly hospitals had 24 beds, 27 percent less than the 33-bed average for all rural closures. Closing monopolies were disproportionately in the smallest bedsize category. Sixty-one percent had between 6-24 beds and they accounted for one-third of rural closures with this bedsize . Monopoly closures in both the 25-49 and the 50-99 bedsize category each represent 14 percent of rural closures. No closing monopolies had over 100 beds.

Monopoly closures also differed from other rural closures in terms of ownership. State or local governments owned 56 percent of monopoly closures compared to 30 percent of all rural closures. Furthermore, although only 2.6 percent of all rural closures were government hospitals, 42 percent of these were monopolies. Although there was a somewhat even distribution of rural closures across ownership catagories, most closings were proprietary hospitals (16%) and 20 percent of these facilities were sole providers for the county . Forty-seven percent of the rural hospitals in 1980 were government owned, but only 3 percent of these hospitals closed, and 42 percent of these closures were monopolies. Forty-four percent of rural hospitals were not-for-profit, but only 3 percent of these hospitals closed, and 5 percent of these were monopoly hospitals.

Areas that experienced a monopoly closure were more sparsely populated than areas with other rural closures. In 1980, counties with monopoly closures averaged 9,000 residents . This is much lower than other rural areas where population averaged 33,400. In 1985, the population increased slightly in these monopoly counties to 9,500. However, this growth did not result in an increase in inpatient admissions.

Monopoly hospitals experienced declining, though fluctuating, admissions between 1980 and in the year of closure. Average admissions in 1980 were 2,137. Admissions in the year these hospitals closed was down 18 percent to 1,753. The two volunteer hospitals suffered the greatest drop, 29 percent. Government hospitals did not fare much better with a drop of 23 percent in utilization before closing. Proprietary hospitals only had an admissions loss

of only one percent. However, these investor-owned hospitals fluctuated in admissions more than the government hospitals. It is possible that after PPS they began heavy marketing to fill beds and increase profits and then closed due to low or no profitability.

For a group of hospitals with a mean of 24 beds, declining admissions can have a significant impact on the financial health of the hospital. As admissions decline, these small facilities do not have enough volume to cover their overhead costs. Government-owned and proprietary hospitals (financial data was available for only 14 of the 25) were working with a negative operating margin during the TEFRA period. Although the operating margin indicates these hospitals were highly unprofitable, it is important to point out that they do not represent large dollar amounts. Generally, these large losses are only from 3,000 to 33,000. An average non-operating revenue of $13,947 per government hospital increased the operating margin from -53 percent to -7 percent. After PPS, operating margins for government hospitals improved. However, by PPS-2 three of the eight government hospitals in the sample had closed, and the amount of revenue necessary to bring the total margin to 8 percent had risen to $24,706.

The proprietary hospitals were also experiencing financial difficulty in TEFRA and their situation became worse with PPS. Not only were their total margins less than the government hospitals' (as low as -88 percent compared to -5 percent for government hospitals), but investor-owned hospitals did not receive much non-operating revenue to increase their total margin. While government hospitals received subsidies of up to $24,706, proprietary hospitals received a maximum of only $5,909.

Monopoly hospitals closed due to declining admissions and a number of years of negative operating and total margins. Although these losses may not have been monetarily large, investors in proprietary facilities did not have any reason to continue operating. With declining admissions, the government hospitals' administrations apparently decided to leave the servicing of the county up to neighboring areas.

Data at the hospital level suggest that patients may be using adjacent

counties' facilities, but without a patient tracer it is not certain where the people of the monopoly closure counties are going. Out of the 13 counties with available data, 62 percent had adjacent counties that showed a slight increase in hospital admissions that could be attributed to the closure of these hospitals. However, many hospitals in adjacent counties also show a decrease in admissions, leaving this conclusion questionable.

Despite the closing of these monopoly hospitals, few counties are in a situation where needs may be unserviced. Half (52%) of the counties are adjacent to MSAs and inspection of road maps show almost all are near cities with medical services. However, the closure of a sole health care facility in a county should give rise to concern. Not only do patients have to travel farther for medical services, but the health education of the area and physician familiarity with the patients are aspects of the services that will most likely not be provided by adjacent county hospitals.

4.3.3 Overall Concentration of Markets under PPS

Finally, Table 4-14 summarizes the effects of exits and entries through their effects on Herfindahl Indexes of concentration for the period before and after PPS. For example, in non-waivered states, there were 87 urban markets with exits through closures or changes to exempt status between 1981 and 1986. In those markets in which exits occurred, the Herfindahl Indexes in 1981 average 0.1607. By 1983, the average index was 0.1639, a change of 0.0032. Following PPS, the Index rose to 0.1735, an additional increase of 0.0096. Both before and after five years of closures, these markets still had an average level of concentration equivalent to having almost six hospitals of equal size in the market. Further, the measures place these hospitals in one of the market categories with higher costs (and presumably more non-price competitive rivalry), and the closures after PPS only reinforced this market condition.

There were 58 urban markets with entries during this same five years.

TABLE 4-14

MEAN HERFINDAHLS FOR MARKETS WITH EXITS AND ENTRIES 1981-1986

	1981	1983	1986
NON-WAIVERED STATES			
Urban			
Exits (87)	0.1607	0.1639	0.1735
Entries (58)	0.1732	0.1632	0.1513
Rural			
Exits (103)	0.6218	0.6737	0.7608
Entries (11)	0.5955	0.6456	0.5958
WAIVERED-EXITS ONLY			
Urban (14)	0.0714	0.0723	0.0772
Rural (5)	0.4119	0.3962	0.6212

Source: Merged AHA Annual Surveys, Medicare Provider of Service File and Cost Reports, Area Resource File.

KLR677121988,KLR689121088,KLR691121988

Many of these also had been the site of closures. The entries made these market less concentrated by 0.0219 index points, and the change was slightly greater after the inception of PPS. However, once again, on average the entry did not alter the level of concentration significantly in terms of moving these markets into a different category. Thus, PPS has seen greater changes in market concentration in both directions for urban hospital markets but the levels do not appear to be important.

For non-waivered rural hospitals, there were 103 exits between 1980 and 1986. Most of these were closures and the rate of rural closure definitely increased in 1984 and 1985. In terms of the Herfindahl Index, the pre-PPS closures increased the average for these markets alone from 0.6218 to 0.6737. After 1983, the concentration index rose to 0.7608, an increase of almost 0.09. The most common change among this group was the closure of one of two hospitals in a rural county, changing the market from a duopoly to a monopoly. In the cost equations, these two categories had insignificant differences in their costs, holding constant other relevant factors.

Rural entries did not affect the overall average concentration, in part because there was at least one closure in these same rural counties during this period. This overlap suggests that the concentration in rural markets due to closures may have been somewhat greater than what is shown because of new rural hospitals in the same markets are also included in the Herfindahl Index for 1983.

In the waivered states, there were no entries and only 19 markets affected by exits. The 14 urban areas with closures or changes to exempt status concentrated these markets only a very small amount. The concentration was greater post-PPS but was not an important amount. In waivered rural markets the five exits increased the average concentration measure by 50 percent from 0.41 to 0.62. This is due to a number of duopolies becoming monopolies in these markets.

Thus, while PPS did lead to more concentration in hospital markets for which of them was it an important change? The report on changes in status

(Hendricks, Dresser, et al., 1988) indicates that the closures that affected concentration most significantly were disproportionately for-profit and government-owned hospitals. For-profit hospitals closed when their profits dropped markedly, whether the drop was accompanied by a large drop in admissions or not. Government closures appear to be more complex decisions because of the role of the government unit and the subsidies many of these hospitals receive. Declining utilization was associated with these closures but the declines had generally existed for a number of years before the decision was made to close the facility.

REFERENCES

Agich, George J. and Charles E. Begley, "Some Problems with Pro-Competition Reforms," Social Science and Medicine, (21)6:623-630, 1985.

Anderson, Gerard and Earl Steinberg, "To Buy or Not to Buy," New England Journal of Medicine, (311)3:182-185, 1984.

Arnould, Richard J., Lawrence W. Debrock, and John W. Pollard, "Do HMOs Produce Specific Services More Efficiently?," Inquiry, (21)3:243-253, Fall, 1984.

Barrett, Diana and Susan R. Windham, "Hospital boards and adaptability to competitive environments," Health Care Management Review, pp. 11-20, Fall, 1984.

Blumstein, James F., "On the Other Hand: Some Comments on Sigelman's Palmistry," Journal of Health Politics, Policy and Law, (6)4:621-624, Winter, 1982.

Brander, James A. and Jonathon Eaton, "Product Line Rivalry," American Economic Review, (74)3:323-334, 1984.

Brown, Lawrence D., "Competition and Health Cost Containment: Cautions and Conjectures," Milbank Memorial Fund Quarterly, (59)2:145-189, 1981.

Christianson, Jon B. and Walter McClure, "Competition in the Delivery of Medical Care," New England Journal of Medicine, (301)15:812-818, 1979.

Clark, J.M. "Toward a Concept of Workable Competition, "American Economic Review, 30: 241-56 (June 1940).

Cohodes, Donald R., "Where You Stand Depends on Where You Sit," Journal of Health Politics, Policy and Law, (7)1:54-79, Spring, 1982.

Cohodes, Donald R., "Which Will Survive? The $150 Billion Capital Question," Inquiry, (20)1:5-11, Spring, 1983.

Comanor, William S. and Thomas A. Wilson, "The Effect of Advertising on Competition: A Survey," Journal of Economic Literature, (17):453-476, 1979.

Cromwell, Jerry and Philip Burstein, The Impact of State Hospital Prospective Reimbursement Programs on Hospital Capital Formation, Competition and Industrial Structure: An Evaluation, No. HCFA-500-78-0036, January, 1984.

Cromwell, Jerry, Gary Gaumer, Judy Williams, and Andrea Hassol, "Case Study Site Report: Northwest Vermont," National Hospital Payment Evaluation, HCFA Contract No. 500-85-0015, September 1986.

Cromwell, Jerry, Martin Gaynor, Judith Williams, and Brooke Harrow, "Case Study Site Report: Albuquerque, New Mexico, National Hospital Prospective Payment Evaluation, HCFA Contract No. 500-85-0015, October 1986.

Custer, William S., "Hospital Attributes and Physician Prices," Southern Ecomomic Journal, (52)4:1010-1027, April, 1986.

Donabedian, Avedis, "The Quality of Care in a Health Maintenance Organization: A Personal View," Inquiry, (20)3:218-222, Fall, 1983.

Elliott, William B. et al., "The Hospital Capitation Payment Project: New Incentives and Tools for Cost Containment," Inquiry, (20)2:114-120, Summer, 1983.

Enthoven, Alan C., "Consumer-Choice Health Plan (First of Two Parts)," New England Journal of Medicine, (298)12:650-658, 1978.

Enthoven, Alan C., "Consumer-Choice Health Plan (Second of Two Parts)," New England Journal of Medicine, (298)13:709-720, 1978.

Enthoven, Alan C., "The Competition Strategy," New England Journal of Medicine, (304)2:109-112, 1981.

Ermann, Dan and Jon Gabel, "Multihospital Systems: Issues and Empirical Findings," (unpublished), National Center for Health Services Research, 1984.

Evans, R. G., "Incomplete vertical integration: The distinctive structure of the health care industry," Health, Economics, and Health Economics, (edited by Van der Gaag, J. and M. Perlman), North-Holland, Amsterdam, 1981.

Farley, Dean E., "Competition Among Hospitals: Market Structure and its Relation to Utilization, Costs and Financial Position," Research Note 7, Hospital Studies Program, DHHS Publication No. (PHS) 85-3353. U.S. Department of Health and Human Services, National Center for Health Services Research and Health Care Technology Assessment, 1985.

Feldman, Roger et al., "The Competitive Impact of Health Maintenance Organizations on Hospital Finances: An Exploratory Study," Journal of Health Politics, Policy and Law, (10)4:675-697, Winter, 1986.

Feldstein, Martin S., "Quality Change and the Demand for Hospital Care," Econometrica, (45)7:1681-1702, 1977.

Feldstein, Martin S., "The Quality of Hospital Services: An Analysis of Geographic Variation and Intertemporal Change," The Economics of Health and Medical Care, ed. Mark Perlman, London: Macmillan, 1974, pp. 402-419.

Flynn, Julie, "American Medical: Huffing and Puffing its way into Shape," Business Week, 16 June 1986, pp. 74-75.

Folland, Sherman T., "The Effects of Health Care Advertising," Journal of Health Politics, Policy and Law, (10)2:329-345, Summer, 1985.

Frank, Richard G. and W. P. Welch, "The Competitive Effects of HMOs: A Review of the Evidence," Inquiry, (22)2:148-161, Summer, 1985.

Freund, Deborah et al., "Analysis of Length-of-Stay Differences Between Investor-Owned and Voluntary Hospitals," Inquiry, (22)1:33-44, Spring, 1985.

Ginsburg, Paul B., "The Competition Debate Five Years Later," Journal of Health Economics, (3)3:307-311, 1984.

Ginzberg, Eli, "The Delivery of Health Care: What Lies Ahead?," Inquiry, (20)3:201-217, Fall, 1983.

Guterman, Stuart, Paul W. Eggars, Gerald Riley, Timothy F. Greene, and Sherry A. Terrell, "The First 3 Years of Medicare prospective payment: An Overview," Health Care Financing Review, 9(3): 67-77, 1988.

Harrison, Deborah H. and John R. Kimberly, "Private and Public Initiatives in Health Maintenance Organizations," Journal of Health Politics, Policy and Law, (7)1:80-95, Spring, 1982.

Hellinger, Fred J., "Perspectives on Enthoven's Consumer Choice Health Plan," Inquiry, (19)3:199-210, Fall, 1982.

Hendricks, Ann , "The Prospective Payment System's Impacts on Rural Hospitals: Overview of Nine Case Studies," HCFA Cooperative Agreement No. 17-C-99102/01, November 1988.

Hendricks, Ann, Marguerite Dresser, Donna Alberts, and Ashley Stone, "Medicare's Prospective Payment System and Changes in the Status of Acute-Care Hospitals," HCFA Contract No. 500-85-0015, September 1988.

Hendricks, Ann, Kavitha Sitaram, and Marguerite Dresser, "Multihospital System Affiliations Among Acute-Care Hospitals Under Medicare's Prospective Payment System," HCFA Contract No. 500-85-0015, October 1988.

Hendricks, Ann M , Elliot M. Stone, and Catherine B. Comstock, "Measures of Local Hospital Markets," paper presented at Western Economics Association, July 1988.

Hersch, Philip L., "Competition and the Performance of Hospital Markets," Review of Industrial Organization, (1)4:324-341, 1984.

Johnson, Allan N. and David Aquilina, "The Impact of Health Maintenance Organizations and Competition on Hospitals in Minneapolis/St. Paul," Journal of Health Politics, Policy and Law, (10)4:659-674, Winter, 1986.

Joskow, Paul L., "The effects of competition and regulation on hospital bed supply and the reservation quality of the hospital," Bell Journal of Economics, (11)2:421-447, 1980.

Keyes, Lucile, "Revised Guidelines - 1984," Review of Industrial Organization, (1)2:154-158, Summer, 1984.

Langwell, Kathryn M. et al., An Annotated Bibliography of Competition in the Financing and Delivery of Health Services, DHHS Publication No. (PHS)83-3326, NCHSR Research Report Series, October, 1982.

Lippincott, Ronald C. and James W. Begun, "Competition in the Health Sector: A Historical Perspective," Journal of Health Politics, Policy and Law, (7)2:460-487, Summer, 1982.

Lipsey, Richard G. and Peter O. Steiner, Economics, Sixth Edition, New York: Harpes & Row, Publishers, 1981.

Longest, Beaufort B., "A Conceptual Framework for Understanding the Multi-hospital Arrangement Strategy," Health Care Management Review, pp. 17-24, Winter, 1980.

Luft, Harold S., "Health Maintenance Organizations and the Rationing of Medical Care," Milbank Memorial Fund Quarterly, (60)2:268-306, 1982.

Luft, Harold S., "How Do Health-Maintenance Organizations Achieve Their 'Savings'?," New England Journal of Medicine, (298)24:1336-1343, 1978.

Luft, Harold S., "On the Potential Failure of Good Ideas: An Interview with the Originator of Murphy's Law," Journal of Health Politics, Policy and Law, (7)1:45-53, Spring, 1982.

Luft, Harold S., "Trends in Medical Care Costs," Medical Care, (18)1:1-16, 1980.

Luft, Harold S., Susan C. Maerki, and Joan B. Trauner, "The Competitive Effects of Health Maintenance Organizations: Another Look at the Evidence from Hawaii, Rochester, and Minneapolis/St. Paul," Journal of Health Politics, Policy and Law, (10)4:625-658, Winter, 1986.

Lynk, William J., "Regulation and Competition: An Examination of 'The Consumer Choice Health Plan'," Journal of Health Politics, Policy and Law, (6)4:625-636, Winter, 1982.

McClure, Walter, "Implementing a Competitive Medical Care System through Public Policy," Journal of Health Politics, Policy and Law, (7)1:2-44, Spring, 1982.

McClure, Walter, "On Broadening the Definition of and Removing Regulatory Barriers to a Competitive Health Care System," Journal of Health Politics, Policy and Law, (2)3:303-327, Fall, 1978.

McClure, Walter, "On the Research Status of Risk-Adjusted Capitation Rates," Inquiry, (21)3:205-213, Fall, 1984.

McClure, Walter, "Structure and Incentive Problems in Economic Regulation of Medical Care," Milbank Memorial Fund Quarterly, (59)2:107-144, Spring, 1981.

McGuire, A. "The Theory of the Hospital: A Review of the Models," Social Science and Medicine, (20)11:1177-1184, 1985.

Melia, Edward P. et al., "Competition in the Health-Care Marketplace," New England Journal of Medicine, (308)13:788-792, 1983.

Melnick, Glenn A., and Jack Zwanziger, "Hospital Behavior Under Competition and Cost-Containment Policies: The California Experience, 1980 to 1985," Journal of American Medical Association, (260)18:2669-2675, 1988.

Mevellec, Pierre, "The Problems Raised by the use of Cost as an Efficiency Indicator in a Biochemical Laboratory," Social Science and Medicine, (21)10:1107-1112, 1985.

Merrill, Jeffrey and Catherine McLaughlin, "Competition Versus Regulation: Some Empirical Evidence," Journal of Health Politics, Policy and Law, (10)4:613-623, Winter, 1986.

Moran, Donald W., "HMOs, Competition, and the Politics of Minimum Benefits," Milbank Memorial Fund Quarterly, (59)2:190-208, Spring, 1981.

Morrisey, Michael A. and Cynthia S. Ashby, "An Empirical Analysis of HMO Market Share," Inquiry, (19)2:136-149, Summer, 1982.

Morrisey, Michael A., Geoffrey Gibson, and Cynthia S. Ashby, "Hospitals and Health Maintenance Organizations: An Analysis of the Minneapolis-St. Paul Experience," Health Care Financing Review, (4)3:59-69, 1983.

Newhouse, Joseph P. et al., "Some Interim Results from a Controlled Trial of Cost Sharing in Health Insurance," New England Journal of Medicine, (305)25:1501-7, 1981.

Pauly, Mark V. and Kathryn M. Langwell, "Research on Competition in the Market for Health Services: Problems and Prospects," Inquiry, (20)2:142-161, Summer, 1983.

Pope, Gregory, Carol Carter, David Juba, and Ray Glazier "Case Study Site Report: Northeastern Iowa," National Hospital Prospective Payment Evaluation, HCFA Contract No. 500-85-0015, November 1986.

Register, Charles V., Ansel M. Sharp, and David G. Bivin, "Profit Incentives and the Hospital Industry: Are We Expecting Too Much?," Health Services Research, (20)2:225-241, 1985.

Reilly, Bernard J. and Joseph P. Fuhr, Jr., "Competition's Flawed Perspective on the Health Care Market and an Alternative Approach," Social Science and Medicine, (17)12:795-801, 1983.

Relman, Arnold S., "The New Medical-Industrial Complex," New England Journal of Medicine, (303)17:963-70, 1980.

Robinson, James C., "Non-price Competition and the Effectiveness of Hospital Rate Regulation," (unpublished), University of California Berkeley, January, 1986.

Robinson, James C., and Harold S. Luft, "The Impact of Hospital Market Structure on Patient Volume, Average Length of Stay, and the Cost of Care," Journal of Health Economics, (4):333-356, 1985.

Robinson, James C., and Harold S. Luft, "Competion, Regulation, and Hospital Costs, 1982 to 1986," Journal of American Medical Association, (260)18:2676-2681, 1988.

Rossiter, Louis F., "Prospects for Medical Group Practice Under Competition," Medical Care, (22)1:84-92, 1984.

Scherer, F.M., Industrial market structure and economic performance, Second Edition , Chicago: Rand McNally College Publishing Company, 1980.

Schmalansee, Richard, "Entry Deterrence in the Ready-To-Eat Breakfast Cereal Industry," Bell Journal of Economics, 9:305-27, (Autumn 1978).

Shleifer, Andrei, "A theory of yardstick competition," Rand Journal of Economics, (16)3:319-327, 1985.

Shortell, Stephen A., Michael A. Morrisey, and Douglas A. Conrad, "Economic Regulation and Hospital Behavior: The Effects on Medical Staff Organization and Hospital-Physician Relationships," Health Services Research, (20)5:597-628, 1985.

Sigelman, Daniel W., "Palm-Reading the Invisible Hand: A Critical Examination of Pro-Competitive Reform Proposals," Journal of Health Politics, Policy and Law, (6)4:578-620, Winter, 1982.

Sisk, Jane E., "Effects of increased competition in health care on the use and innovation of medical technology," Health Care Management Review, pp. 21-34, Summer, 1984.

Thomas, William J. et al., "Increasing Medicare Enrollment in HMOs: The Need for Capitation Rates Adjusted for Health Status," Inquiry, (20)3:227-239, Fall, 1983.

Thurow, Lester C., "Medicine Versus Economics," New England Journal of Medicine, (313)10:611-614, 1985.

Vladeck, Bruce C., "The Dilemma Between Competition and Community Service," Inquiry, (22)2:115-121, Summer, 1985.

Vladeck, Bruce C., "The Market vs. Regulation: The Case For Regulation," Milbank Memorial Fund Quarterly, (59)2:209-223, Spring, 1981.

Watt, J. Michael et al., "The Comparative Economic Performance of Investor-Owned Chain and Not-for-Profit Hospitals," New England Journal of Medicine, (314)2:89-96, 1986.

Watts, Carolyn A. and T. D. Klastorin, "The Impact of Case Mix on Hospital Cost: A Comparative Analysis," Inquiry, (17)4:357-367, Winter, 1980.

Webster's New International Dictionary of the English Language Second Edition, Unabridged, Springfield, Mass: G. & C. Merriam Company, Publishers, 1955.

Weiner, Stephen M., "On Public Values and Private Regulation: Some Reflections on Cost Containment Strategies," Milbank Memorial Fund Quarterly, (59)2:269-296, Spring, 1981.

Welch, W. P., "HMO Enrollment: A Study of Market Forces and Regulation," Journal of Health Politics, Policy and Law, (8)4:743-758, Winter, 1984.

White, William D., "Regulating Competition in a Non-profit Industry: The Problem of For-profit Hospitals," Inquiry, (16)1:50-61, Spring, 1979.

Wright, Richard A. and Bruce H. Allen, "Marketing and Medicine: Why Advertising is Not an Issue," Journal of the American Medical Association, (250)1:47-48, 1983.

Zuckerman, Stephen et al., "Physician Practice Patterns Under Hospital Rate-Setting Programs," Journal of the American Medical Association, (252)18:2589-2592, 1984.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES --

THE IMPACT OF MEDICARE'S PROSPECTIVE PAYMENT SYSTEM ON TECHNOLOGY DIFFUSION

Working Paper

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THE IMPACT OF MEDICARE'S PROSPECTIVE PAYMENT SYSTEM ON TECHNOLOGY DIFFUSION

1.0 INTRODUCTION

In the Fall of 1983, HCFA began implementing a novel payment system for hospitals. Rates were determined based on average costs within approximately 470 Diagnosis Related Groups (DRGs) and paid upon discharge without any year-end settlements for additional costs. Not all costs were covered under the fixed rates. Capital costs, mainly depreciation and interest, continued to be reimbursed on a passthrough basis, although the Congress has authorized rollbacks in payments (currently 15 percent).

The industry's responses to the system were generally in the expected direction, but much more aggressive than anyone had predicted. The easiest way hospitals could cut costs would be to shorten stays, and Medicare lengths of stay fell almost 10 percent in the first year, followed by another 6 percent in year two (DHHS, 1986, Table 3-4). Administrators also began shifting the site of care to the ambulatory setting, either to reduce costs or to generate extra revenues in their outpatient facilities that were still reimbursed based on incurred costs.

All of these incentives and trends support a hypothesis of less diffusion and adoption of costly inpatient ancillary services. Prospective payment for operating expenses greatly increases the financial risk of underutilizing cost-increasing technologies. In particular, profits are automatically reduced if a hospital uses a particular piece of equipment in the treatment of a Medicare patient because the final payment is fixed. Moreover, the incentive to shift the site of care should lead to less hospital adoption and more diffusion to noninstitutional settings. And finally, the unexpectedly large volume declines should make new investments even riskier in terms of uncovered payments.

On the other hand, other factors could produce an opposite conclusion. The fact that capital costs have been treated as a passthrough to date encourages hospitals to substitute capital for labor. How much substitution is possible depends upon the type of equipment. Computers can easily substitute for labor in a variety of functions, but CAT scanners may require more complementary personnel to manage, administer, and interpret the procedure.

We also know that hospital profits in the first three years of PPS were at historical highs (ProPAC, 1988, p.46). This seems to have been a result of higher than expected payments per case and cost cutting and site shifting. Large windfall profits produce substantial "income effects" that may offset any negative "price effects" inherent in greater investment risk under fixed payment. Hospitals simply had a lot of reserves burning a hole in their pockets.

Finally, now that hospitals are being paid (by Medicare) only when they admit patients, they are no longer financially indifferent to interhospital rivalry. Whereas under cost-based reimbursement hospitals could aggressively compete for patients or not, without worrying about covering their sizable fixed costs, now they must compete or see payments fall accordingly. This places a premium on projecting a positive community image to attract patients, which in turn revolves around having the latest technologies. This suggests that the effects of declining volumes on adoption are ambiguous. On the one hand, they discourage the adoption of services due to the greater utilization risk, while on the other hand they force hospitals to adopt certain services faster than they might otherwise have in order to avoid risking an unacceptable drop in community support and possible bankruptcy.

The purpose of this paper is to explore the relationship between PPS and the diffusion of complexity-expanding, support, and outpatient services; to see if PPS in its initial phase really discouraged the adoption of new services and technologies. If it did, we would be able to say a little more about how hospitals behave when actually faced with fixed or declining budgets. Slower adoption rates could also be indicative of a potential problem with prospective payment; namely, the suppression of beneficial technical change.

We will also examine the growth in outpatient services to see if hospitals have been competing by reaching out into the community with new services or by following up patients who are being discharged earlier than in the past. Unfortunately, we will not be able to say whether any growth in outpatient activity is due to PPS site-of-care incentives or to rivalrous behavior, but it is important to lay out the facts as we now know them.

The paper will also address the question of access to services in a limited way. This is done by asking a couple of key questions. Are rural hospitals adopting complexity-expanding and outpatient services at rates similar to urban hospitals? Are new technologies diffusing to new MSAs or just "piling up" in cities already oversupplied?

The paper includes both descriptive and multivariate research. Descriptive trends indicate how much diffusion of complex versus outpatient services has occurred in the last few years while multivariate analysis is used to isolate PPS effects from other underlying causes.

2.0 DATA SOURCES

Two data sources are used for the study. The main source is the AHA Annual Survey of Hospitals for the 1980-86 period. This survey ask hospitals whether they provide at their own institutions a list of 50-60 individual services, or whether it is available in a shared arrangement with another local institution. We collapsed the choices to a 0,1 variable indicating whether the service was provided by the particular institution.

The annual survey also ask hospitals about 25 different types of bed accommodations, e.g., pediatric, neonatal ICU, rehab. Thus, we know how many beds in each accommodation the hospital had set up and staffed on the last day of its fiscal year. Several of these bed categories are also reported as a 0,1 service, but we prefer the bed data for two reasons. First, they are more indicative of a hospital actually providing the service on-site rather than through some referral arrangement. And second, the number of beds provides a measure of the depth of commitment to the service, which is unfortunately lacking in the rest of the facility and service data.

Given our interest in PPS effects on diffusion, we first subsetted the universe of short-term general hospitals to those generally eligible for PPS: namely general medical and surgical; obstetrics and gynecology; eye, ear, nose, and throat; and orthopedic. Specialized hospitals designated as psychiatric, rehabilitation, and chronic disease were some of the types of hospitals excluded from our analysis. This data set consisted of approximately 5,600 hospitals per year. We further eliminated federal hospitals and those in the four waivered states (NJ, MA, MD, NY), leaving a data set that consisted of 54 percent voluntary, 15 percent proprietary, and 31 percent state and local hospitals. The resulting sample used for our analysis contained data from approximately 5,100 reporting hospitals per year.

The second data source includes the Medicare Cost Reports for a large subsample of PPS-eligible hospitals (over 4,000). Besides having financial data on profits and capital assets not reported by the AHA, this file also has key HCFA payment information such as the hospital standardized amounts, indirect medical education status, and the local PPS wage index. They are also useful in defining urban and rural status for Medicare payment purposes.

As part of a larger evaluation of PPS undertaken by Abt Associates and Health Economics Research, Inc., the AHA and Medicare Cost Report data were merged, together with county-level data from the Area Resource File. In the merged data file, observations are organized by hospital and payment system. Thus, each variable has observations for each hospital in each payment system. There are four payment systems: "TEFRA," which is the fiscal year before PPS, and the first three years of PPS (PPS1-PPS3). Because of the wide range of hospital service and financial variables, and area characteristics, the merged file was used for the multivariate estimation reported in Section 5.

3.0 DESCRIPTIVE TRENDS BY TYPE OF SERVICE

This section provides summary data on descriptive trends in hospital service adoption and bed accommodations. The first subsection reviews the growth in alternative bed types. This is followed by three other subsections describing the diffusion of complexity-expanding, support, and outpatient services.

3.1 Bed Accommodations

Table 1 reflects the rather remarkable diversification of U.S. short-term general hospitals that has taken place in a few years under prospective payment. Most noticeable is the rapid growth in subacute forms of care. The percent of "acute care" hospitals offering subacute SNF, psychiatric and other forms of traditional subacute care went from 14.8 to 18.7 percent. Even more dramatic is the growth in special forms of subacute care. Rehabilitation bed care could be found in 4.7 percent of hospitals in 1982. By 1986, the percentage had doubled to 9.4 percent, with nearly one-in-ten hospitals providing rehab bed care. Swing beds grew even faster, going from 1.1 percent to 8.5 percent of hospitals over 4 years.

Within acute services, hospitals have clearly diversified into psychiatric and alcohol/chemical dependency beds. The latter has been particularly popular, doubling in frequency in just 4 years. Nearly one-in-seven hospitals had beds designated to treat alcohol and chemical dependency patients by 1986.

Within intensive care units, the trends are mixed. General medical-surgical ICUs continued to diffuse through 1984, then fell slightly (to 74.3 percent) two years later. Cardiac ICUs also appear to have become less popular between 1984 and 1986. This may be because declining volumes have encouraged hospitals to merge their general med-surg and cardiac ICUs.

Other ICU types, however, continue to diffuse: neonatal units up from 8.0 to 10.4 percent of hospitals; pediatric units up from 3.4 to 4.6 percent; and burn care units up 0.1 percent.

All of these trends seem consistent with PPS incentives to (a) stratify acute bed units more sharply to provide more subacute care for med-surg patients, (b) shift care away from PPS-covered to excluded services (e.g., psychiatric care), and (c) diversify to other forms of care that are less intensive or provide alternative sources of revenue (e.g., rehab).

3.2 Complexity-Expanding Services

Of particular interest is the effect of prospective payment on the diffusion of complexity-expanding inpatient services. These usually reflect the latest, most beneficial, and most costly medical technologies. Given the high cost of most of these services, the direct PPS response should be to slow their diffusion, which would be reinforced by the extraordinary volume declines occurring since 1983.

Table 2 shows the diffusion of 12 of these services over the 1981-86 period. Diffusion of certain complexity-expanding technologies has been particularly rapid over the first six years of the decade. In 1982, CT scanners were in 30 percent of short-term hospitals; four years years the percentage had doubled to nearly 60 percent. Nuclear magnetic resonance (NMR) first started being reported in 1983. In just three years its diffusion level had also doubled from 3 to 6 percent. Diagnostic ultrasound is also a fast diffusing new technology, even though over 70 percent of hospitals reported having the service in 1981. By 1986, 86 percent had ultrasound capabilities, implying that it had diffused to a significant number of small rural hospitals.

Open heart surgery and its complementary service, cardiac catheterization, have also continued to diffuse throughout the pre- and post-PPS period. In 1983, 11.1 percent of hospitals offerred the service, or one-in-nine. By 1986, 13.1 percent were performing open heart surgery, or one-in-7.5 hospitals. This diffusion rate does not compare with that of CT scanners and NMR, but is noteworthy nevertheless considering how expensive (and risky) it is for a hospital to enter this field.

Five core radiological technologies have diffused very slowly if at all during the 1980s. This may partly be explained by the substitution of noninvasive CT scan and NMR technologies. It may also be the result of shifts in the site to ambulatory clinics not part of the hospital.

Table 3 shows variations in the level and rate of diffusion of the 12 complexity-expanding services by hospital size, type, and location. To simplify the presentation, we aggregate across the services and present trends in the percentage of the 12 services provided. Thus, in 1981, the typical U.S. short-term general hospital had 27 percent, or a little over 3.2 of these services. By 1986, the percentage had risen to 30 percent, or 3.6 services, an 11 percent increase in the adoption share. This is not a very rapid increase--particularly compared to some other service groups shown later, but the trend is deceiving in that some complex services did not diffuse at all between 1982-86 or were actually negative on a net basis (e.g., radiation therapy).

It has been known for a long time that diffusion levels are highly correlated with hospital bedsize (Berry, 1973; Russell, 1978; Cromwell and Kanak, 1982). This is clearly illustrated in Table 3. The under-100 bed urban hospital averaged 12.3 percent of the 12 services in 1981, or 1.5, versus nearly 86 percent, or 10.3 services, for the over 504-bed hospital. Size also explains most of the regional, teaching, and ownership differences observed in Table 3 (see multivariate results below).

The rate of diffusion, on the other hand, is usually inversely related to the level of adoption. That is, hospitals already having a large number of complex services are, by definition, going to have a smaller percentage increase in their overall adoption level if they add an additional service.

This, too, is evident in Table 3 from a comparison of changes in the percent of services provided shown in the last column. The average under-100 bed urban hospital had nearly a 36 percent growth in its percent of complex services in 6 years compared to 8.8 percent growth in the 405-504-bed group (and negative growth among the very largest urban hospitals). In absolute numbers, however, the 405-504-bed group adopted .72 new complex services on average versus just .52 for the under-100 bed group.

At least in percentage terms, the small, under-50, bed rural hospital exhibited the highest adoption rate between 1981 and 1986: 52.5 percent. This amounted to the adoption of only about .3 complexity-expanding services, however. The 50-99-bed hospital had the highest absolute change among rural hospitals, adopting .61 new services. Yet, given the financial problems of the small rural hospitals in recent years ProPAC, 1988, pp.68-72; Hendricks, et al., 1988, ch.6), brought on by very large volume declines, it is noteworthy that they continue to adopt any of these expensive complex services.

Because of their smaller average bedsize, rural hospitals have only about one-third of the complexity-expanding services offerred in urban hospitals. Moreover, even though their rate of adoption is higher in percentage terms than urban hospitals, the latter did adopt slightly more new complex services over the six year period (i.e., .42 vs. .31 in rural hospitals).

3.3 Medical Support Services

Complex services are the primary way new, life-saving technologies are introduced into the medical sector. Certain support services also serve an important role in rehabilitating patients after traumatic surgery and assuring that other hospital services are of high quality and effectiveness. Seven of these services are shown in Table 4. The first two, blood bank and histopathology lab, have hardly diffused at all between 1982 and 1986. The rest, by contrast, show continued diffusion, even though two, physical and respiratory therapy, were already at high levels. The rapid growth in all the therapies coincides with the hospital's need to rehabilitate patients quicker before discharge, as well as to diversify into new revenue-generating services.

3.4 Outpatient Services

The third set of services to be analyzed reflects the institution's outreach into the community. PPS incentives to diversify and follow patients after discharge are strong to make sure they are adequately cared for and to generate revenues to offset inpatient volume declines.

Table 5 presents 4-year diffusion trends for 10 outpatient services. The changes are impressive. Slightly over 38 percent of hospitals had an organized outpatient department prior to PPS; by 1986, the percentage had jumped to 63 percent. Outpatient alcohol/chemical dependency services went from 10.8 to 16.5 percent; occupational therapy from 32.8 to 43.2 percent.

Of course, the most remarkable of all is an organized home health program provided by the hospital. In 1982, only 12.2 percent of hospitals offerred this service to discharged patients. Just four years later the percentage had tripled to 35.4 percent. And this is just home health services provided directly by the hospital and does not include the many non-hospital-based agencies offering such services.

Table 6 summarizes the overall adoption shares for eight selected outpatient services by hospital size, type, and location. Overall, in 1982, the average hospital provided 35.4 percent of the eight services, or 2.8 services. Four years later, the percentage was 44.3, an increase to 3.6 services.

As with complexity-expanding services, diffusion levels correlate strongly with bedsize, although the percentage difference between small and large hospitals is not quite as great. And while the rate of diffusion is still generally inversely correlated with initial diffusion levels, the trends are much looser. For example, the under-50 bed rural hospital raised its adoption level nearly 9 points between 1982 and 1986 compared to a 12 point increase for over-169 bed rural hospitals. The former change was greater in percentage terms, but less in absolute terms, i.e., .7 vs 1.0 services. Even the very large urban hospitals added more than half an outpatient service (out of eight).

4.0 DIFFUSION OF SERVICES WITHIN MSAs

The preceding section presented trends in the level and rate of adoption of various kinds of hospital services but they do not give a very good picture of patient access over time. Specifically, aggregate trends do not tell us whether a second hospital in the same city began performing open heart surgery or whether this service was being offerred for the first time in another city.

Similar kinds of diffusion trends are presented in this section, but this time they are aggregated by MSA (all rural areas are excluded due to a lack of a well-defined market). For selected bed accommodations and service groups, we report the number of MSAs with 1, 2, 3, or more hospital-based units. While this is by no means definitive regarding patient access, even in cities, it does shed some light on the geographic nature of the diffusion. We may also be able to say something about the extent of hospital service rivalry under PPS.

4.1 Bed Accommodations

Table 7 shows the distribution of 326-30 MSAs by the number of bed accommodations of a selected type in each of three years. The bed types reflect the availability of various kinds of intensive care as well as two community-oriented services; namely, rehab and alcohol/chemical dependency. The distributions show, for example, that general med/surg ICU beds were available in all but 6 MSAs in 1982 and that 46 MSAs had 11 or more ICU units in 1982. In sharp contrast, 233 MSAs were without distinct burn care units in 1982 while 2 MSAs had at least 5.

If units are diffusing to heretofore unserved cities, the number of MSAs without a particular accommodation will fall over time and the number with 1 unit will rise. Furthermore, the number of MSAs with a given number of units may rise or fall over time depending on whether hospitals in an MSA added or subtracted services.

Medical/Surgical ICUs provide a good reference service in that their distribution is almost unchanged over the 1982-86 period. Thus, on net, about as many MSAs had, say, 3 such ICUs in 1986 as in 1982 (actually there were 3 less MSAs). And while there were 5 fewer MSAs with a single unit, in 1986 versus 1982, it was not that these areas went unserved. MSAs with 2 units actually increased slightly, suggesting that a couple of MSAs adopted a second unit. (There is also a slight increase in the number of MSAs over the period from 326 to 330, which could explain the increase in the number of unserved MSAs between 1984 and 1986.)

The two accommodations showing the greatest geographic diffusion are neonatal ICUs and rehabilitation beds. In 1982, 146 MSAs were without a neonatal unit compared to 111 four years later. Most of the unserved MSAs in 1982 apparently had a single unit by 1986, as evidenced by the sizable increase in the number of MSAs with a single unit (127 versus 105 in 1982). The growth in the number of MSAs with three or more such units is striking as well: 55 in 1986 vs. 35 in 1982.

Diffusion of rehab units within and across MSAs is even more pronounced. In 1982, 209 MSAs were without a rehab unit compared to 145 four years later. (It should be kept in mind that our sample excludes rehad hospitals, per se.) Again, about one-half of this change is explained by a heretofore unserved city getting a unit, but the diffusion among areas already having several units is again striking. Forty-six MSAs had 3 or more units in 1986 vs. 18 in 1982. In spite of several hospitals already offering rehab, competitors apparently see the need, or the financial opportunity, to open new units. Whether this kind of diffusion substantially improves access is a fair question.

Cardiac ICU units present an interesting counter-example of a service that may be becoming more regionalized over time. First, although the number of unserved MSAs grew only slightly, the number of MSAs with just one cardiac-specific ICU increased by 20 in just 4 years. Conversely, the number of MSAs with 3 or more units fell by 19 from 117 to 98. This suggests that the need to have specially-designated units in cities where many already exist is being re-evaluated in an era of declining volumes and greater cost consciousness.

4.2 Complexity-Expanding Services

Table 8 presents an identical table for eight complexity-expanding services. We have already seen that open heart surgery has diffused gradually from about 10 to 13 percent of all hospitals. Given that practically all such operations are done in urban hospitals, what does this imply for access in the city? As of 1982, 134 MSAs did not have an open heart surgery suite. By 1986, the number without a suite had fallen to 114, implying that 20 new cities now had the capability. However, only 4 more MSAs on net reported having a single suite, implying further diffusion of suites into cities already having the capability. For example, in 1982, there were 30 MSAs with at least 5 open heart surgery suites. By 1986, just four years later, there were 42, an increase of 40 percent.

The drop in the number of MSAs without cardiac catheterization was even greater as 31 picked up at least one such service. Again, the net increase in MSAs with a single unit was minimal (i.e., one) as the technology diffused into cities already having one or more units. For example, the number of MSAs with 6 or more units increased from 34 to 46, or 35 percent.

We have already noted in Table 2 that CT scanners were the most rapidly diffusing complex technology over the 1982-86 period. But even by 1982, the vast majority of cities already had at least one scanner (only 14 did not). By 1986, virtually all had a least one scanner (only 1 in 330 MSAs did not). Again, the diffusion was so strong that the number of MSAs having zero, one, or two scanners actually fell during the period. Forty new MSAs had 3-5 scanners and 41 new MSAs had 6 or more. A similar diffusion pattern is evidenced for diagnostic ultrasound, although this technology seems further along in its overall diffusion.

Nuclear magnetic resonance is an interesting case as we pick up its diffusion at its initial stages, much like CT scanners in the late 1970s and early 1980s. As expensive as CT scanners are, NMR is even more so, making its diffusion an even more costly one. This technology is so highly regarded that ProPAC requested a special add-on to the DRG rate whenever the procedure is done so as not to discourage its diffusion.* Whether such an add-on was needed is debatable after looking at the diffusion of this very expensive technology. In 1982, 319 MSAs out of 326 did not have the service, or 98 percent. Four years later, only 201 of 330 MSAs (or 60 percent) were without the service. Actually, even this is probably a significant understatement of its availability given the diffusion of the service to non-hospital settings. It should be remembered that our figures apply only to hospitals. Of the 118 MSAs that adopted at least one new NMR unit, 59 can be accounted for as having one unit by 1986. The number of MSAs having 2 such units went from 2 to 28. Finally, as of 1982, no MSA had more than 2 hospital-based units compared to 37 MSAs with 3 or more by 1986. These trends suggest that NMR is diffusing rapidly in cities throughout the country, both in MSAs without units as well as among larger cities already served by a few units.

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*ProPAC recommended a $124 add-on for each scan, updated annually, for at least three years (ProPAC, 1986, p. 53). HCFA rejected the add-on and it was never implemented.

Organ transplant the only complex service showing no real diffusion. In fact, 4 MSAs on net appear to have loss this capability between 1982 and 1986. If anything it appears that this very complicated and costly service is becoming more regionalized in spite technical changes that make this capability more feasible.

4.3 Outpatient Services

Table 9 provides similar geograhic dispersion data for eight outpatient services. As of 1982, there were 33 MSAs where patients had no organized outpatient department (OPD) to go to, although all but 2 MSAs had at least one emergency department. Four years later, only 9 MSAs were still left without a hospital outpatient department. In fact, the diffusion of OPDs appears throughout the urban markets regardless of how many competitors originally existed. For example, 78 MSAs had at least 5 OPDs in 1982 vs. 118 four years later. Hospitals are clearly seeing it in their financial interests to open their own OPD to follow their own patients outside the hospital and possibly to avoid leakages of patients to other hospitals already having units.

Even by 1982, practically all MSAs had access to at least one hospital-based ambulatory surgical service. Interesting, however, is the large increase in the number of MSAs having 11 or more such services, which suggests almost 100 percent diffusion of ambulatory surgery in even the largest markets.

Both outpatient alcohol/chemical dependency and psychiatric services continued to show strong diffusion to unserved MSAs over the early PPS period, with 52 and 30 newly-served MSAs, respectively.

And finally, the outpatient department notwithstanding, home care remains the clear leader in its diffusion to new urban markets. As late as 1982, 173 MSAs were without a hospital-based home care program, or over half of our cities. By 1986, only 57 (or 17 percent) were still without at least one hospital-based program. One hundred and sixteen new MSAs adopted at least one home care program, and many MSAs that already had several continued to see more spring up as hospitals scrambled to follow their patients and generate additional revenues. Whereas 14 MSAs had 5 or more hospital-based home care programs prior to PPS, by 1986, 54 had 5 or more.

5.0 REGRESSION TESTS OF PPS IMPACTS ON SERVICE DIFFUSION

5.1 Variable Definitions, Specification, and Econometric Issues

The diffusion curves of many hospital technologies are long relative to the time hospitals have been subject to Medicare's Prospective Payment System. Lags in data gathering further reduce available post-PPS observations. For these reasons, time series analysis currently provides only limited evidence of PPS impacts on technology or service diffusion.

Exploiting cross-sectional variation in PPS impacts on hospitals is a more promising way of measuring short-run PPS effects on diffusion. We use two variables to capture cross-sectional variation in PPS impacts in our multivariate work. The first measures the predicted short-run financial gain (or loss) of a hospital from PPS. The GAIN variable is the product of Medicare dependence (defined as the share of costs due to Medicare patients in the TEFRA year) and the percentage difference in a hospital's first-year PPS payments per case and its TEFRA costs per case*. The hypothesis is that the more a hospital gains financially from PPS, the more likely it is to add new services or technologies. Conversely, the greater financial pressure PPS puts on a hospital, the less likely it is to add services, or the more likely likely it is to eliminate them, in an attempt to constrain its costs. The second cross-sectional variable is Medicare dependence (defined as above). Hospitals that are more dependent on Medicare business should exhibit more strongly any PPS effects.

The limitations of these two variables as measures of PPS effects should be noted. The GAIN variable measures only the direct financial impact of PPS. Its cross-sectional variation does not capture the change in incentives faced by all hospitals as the result of the transition from cost-based to prospective reimbursement. A hospital with the same financial surplus might behave differently facing cost versus prospective reimbursement. Moreover, it measures the PPS financial impact assuming no behavioral response. Hospitals' actual margins under PPS may have been quite different as they undertook cost-cutting measures such as reducing length of stay.

The effects of Medicare dependence are relative to reimbursement methods used for non-Medicare patients. Effects will differ depending on whether non-Medicare patients are reimbursed by prospective, cost, charge-based, or other methods. The Medicare dependence variable takes no account of variation in these methods from hospital to hospital, area to area, or over time. It does not measure the effects of Medicare's PPS relative to previous cost-based reimbursement unless non-Medicare patients are reimbursed exclusively on a cost basis in the post-PPS era.

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*Other studies of PPS impacts (e.g., Feder, Hadley, and Zuckerman, 1987; Lave et al., 1988) have used a similar variable to measure PPS impacts.

In addition, in the dependence variable, effects of PPS may be confounded with casemix differences of Medicare and non-Medicare patients. We are able to control for Medicare casemix in our regressions through a DRG-based casemix index. Unfortunately, we have no information on non-Medicare casemix. Since Medicare patients, on average, are more difficult to treat and require more services than non-Medicare patients, a positive coefficient on Medicare dependence may be picking up the more difficult casemix of Medicare patients, rather than the effects of prospective payment.

To test PPS effects, we include the GAIN and Medicare dependence variables in regressions explaining hospital adoption of services. Several regressions explain the adoption of two individual services, CT-scanner and Nuclear Magnetic Resonance Imager (NMR). Multi-service counts of complexity-enhancing services and outpatient services are the dependent variables in other regressions.

To isolate PPS effects, other factors influencing service adoption must be held constant. Many of these factors are of interest in their own right. Without a formal model at this stage of our research, we specify hospitals' level and rate of adoption of services as a function of the benefits and costs to the hospital of adding services (Russell, 1984). The benefits of service adoption are higher when there is a greater demand for them. For many services, demand is primarily a derived demand from the number and type of cases treated (Romeo, Wagner, and Lee, 1984). Hospital bedsize proxies for volume of derived demand and also for cost per case as larger hospitals can more efficiently utilize indivisible equipment and services. The change in the number of discharges measures changes in derived demand. A positive effect of Medicare casemix on service adoption is expected because more complex cases increase the demand for services. Teaching status and bedsize also pick up derived demand from difficult cases or teaching functions. County per capita income is expected to have a positive effect on service adoption as higher income raises demand. Population density will have a negative coefficient if travel time to hospitals is greater in less densely populated areas, increasing demand for services at hospitals existing in those areas. A larger number of physicians per capita may raise demand for services or proxy for other, unmeasured factors that increase the demand for medical services in an area.

The costs of service adoption are more difficult to measure than the benefits. Prospective payment creates an opportunity cost of adding services (Russell, 1984). Therefore, it is expected to slow service diffusion relative to cost-based reimbursement. Adding services invariably raises labor costs.

For example, the one-year operating costs associated with CT-scanners or NMRs are roughly equal to the total capital expenditure (Hillman, 1986). If higher labor costs discourage service adoption, we expect a negative coefficient on the PPS hospital wage index we include in the regressions. Hospitals belonging to multihospital systems may have a lower cost of capital which encourages service adoption. If so, this variable will have a positive coefficent. Similarly, hospitals with greater financial surpluses may face a lower cost of capital if retained earnings are cheaper than external borrowing. Indeed, nonprofit hospitals with surpluses face the necessity of reinvesting them. For both reasons, a positive coefficient on a hospital's total margin is expected.

Several other independent variables are included in the regressions. Competitive considerations have been shown to affect hospital service adoption (Luft et al., 1986). To measure competition, we include two variables. A Herfindahl index of beds measures the general potential for competition in a hospital's market area. The percent of neighboring hospitals with the service in question measures specific product line competition.* For urban hospitals, the Herfindahl index is defined for SMSAs; for rural hospitals, it is defined for a hospital's county and contiguous counties, whether urban or rural.** Neighboring hospitals are those within the sample hospital's county. For-profit and government ownership measure differences in the hospital's objective function. It is often argued (e.g., Shortell et al., 1987) that proprietary hospitals are less likely to offer a full range of services than other hospitals while government hospitals are more likely to do so. The percent of (other) services offerred measures a hospital strategy of being a full-service, technically sophisticated hospital, making it more likely to adopt the service(s) in question. It also captures any unmeasured factors making the sample hospital more likely to adopt services. We plan to include variables measuring the presence and stringency of state CON programs and regulation of hospital reimbursement. These variables should clarify the Medicare dependence variable by helping control for reimbursement methods for non-Medicare patients. Unfortunately, they were not available to us at the time this paper was written.

In the multivariate work, we used the Abt/HER PPS evaluation file described in Section 2. It provides data on the relevant hospital and area variables discussed above. Hospitals are classified based on the Medicare payment system they were subject to rather than calender time. For this study, we had data for Medicare-eligible hospitals running from "TEFRA," the year prior to a hospital's going on PPS, to the third year of PPS (called PPS 3).

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*For the multiservice index regressions, this variable is defined as the average number of services of a specified type among neighboring hospitals.

**We are grateful to our colleague Ann Hendericks for creating the Herfindahl index.

Several difficult statistical issues are present in estimating the relationship between service adoption and its determinants with our data. The data is both right and left censored. That is, the timing of adoption of hospitals that adopted before the TEFRA year is unknown ("left censoring") as is the adoption time, if any, of hospitals that had not adopted by PPS 3 ("right censoring"). In addition, our theoretical specification is what is known in the econometrics literature as a "switching regimes" model. This is because the coefficients of several of our variables may change over time. The GAIN variable is expected to be zero for hospitals which adopted technologies before PPS because it was not relevant to decisions then.* Coincident with PPS, it is expected to be non-zero. Similarly, the coefficient on the Medicare dependence variable might change sign from positive to negative if cost-based reimbursement preceeding PPS encouraged service adoption while PPS discourages it. Econometric techniques to appropriately account for these issues separately exist (Lee and Waldman, 1985; Maddala, 1983). However, accounting for them jointly raises complex problems that we are currently evaluating.

For this paper, we have adopted the following (imperfect) estimation strategy. For each of our dependent variables--CT-scan adoption, NMR adoption, count of complexity-enhancing services, and count of outpatient services--two equations were estimated. The first explains the baseline, Pre-PPS level of service adoption in the TEFRA year. For the CT-scan and NMR regressions, the dependent variable is 0=the hospital did not have the technology in the TEFRA year, 1=the hospital had the technology in the TEFRA year, according to the AHA annual survey. For the service indexes, the dependent variable is the number of services each hospital reported in the relevant category in the TEFRA year. Definitions of "complexity-enhancing" and "outpatient" services are similar to those used in the descriptive work above.** Several independent variables relevant only to the post-PPS period are excluded from these regressions. Both NMR regressions are restricted to urban hospitals because virtually no rural hospitals had NMRs in our sample period. The sample for the other three regressions is all hospitals with complete (i.e., nonmissing) data.***

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*The long-lived nature of capital and anticipation may mean that expected PPS effects were relevant before PPS was actually implemented, but it is unlikely that these anticipation effects occurred for more than a short period before PPS implementation.

**Blood bank and histopathology were added to the complexity-enhancing services, while organ transplant was excluded. In addition, day hospital and geriatric services were added to the outpatient services, while psychiatric emergency services and occupational therapy were excluded.

***Missing data due to the lack of the 1987 AHA Annual Survey tape at the time our data file was created limits the sample size.

The second equation explains adoption behavior post-PPS, between the TEFRA and PPS 3 years. For the CT-scan and NMR regressions, the sample is restricted to only those hospitals that did not have the technology in the TEFRA year. The dependent variable is 0=still did not have the technology in PPS 3, 1=had the technology in PPS 3. For the indexes, the sample is all hospitals and the dependent variable is the change in the number of services offerred between TEFRA and PPS 3, which may be positive or negative. Therefore, these latter two equations explain disadoption behavior, as well as adoption behavior. Since the number of services which a hospital could potentially adopt between TEFRA and PPS 3 is limited by the percentage of services it already offerred in TEFRA, the percentage of services in TEFRA and the percentage squared are entered in the index regressions. To minimize potential endogeneity problems, TEFRA year values of independent variables were generally used.

Joint interpretation of the two equations for each dependent variable provides a meaningful picture of hospital service adoption and PPS impacts. For this paper, the reported results are based on ordinary least squares estimation of the equations. However, because the dependent variables in the CT-scan and NMR equations are binary variables, they would be more appropriately estimated by probit. We are currently doing so.

5.2 Results

We will first discuss results for the two individual services, CT-scan and NMR, then take up the results for the counts of complexity-enhancing and outpatient services. CT-scan provides a good chance to estimate the impact of PPS on "big-ticket" technology adoption because it was diffusing rapidly during the period when PPS was introduced (see Table 2).

The two CT-scan regressions are reported in Table 10. The PPS GAIN variable is excluded from the first regression as irrelevant to pre-PPS adoption decisions. The coefficient of the GAIN variable is not statistically different from zero in the second regression. That is, the predicted financial gain from PPS has no statistically significant effect on the likelihood of CT-scan adoption by PPS 3 among hospitals that had not adopted by the TEFRA year.

Medicare dependence is included in both regressions since it is potentially relevant to pre- or post-PPS decisions, although possibly with different signs. Pre-PPS, Medicare dependence has a statistically significant positive effect on the likelihood of adoption of CT-scan. A hospital with 100 percent Medicare volume is estimated to have a 12 percent greater likelihood of a having a CT-scan in the TEFRA year than a hospital with no Medicare volume. This effect is consistent either with Medicare cost-based reimbursement promoting technology adoption, or with the more severe casemix of Medicare patients increasing the likelihood of adoption. Post-PPS, Medicare dependence continues to have a positive effect of similar magnitude on adoption, but the coefficient is no longer significantly different from zero.* Taken together, the pre- and post-PPS coefficients do not provide any strong evidence of a change in the effect of Medicare dependence on technology adoption post-PPS.

The negative Herfindahl coefficients indicate that more potential competition among hospitals increases the likelihood of adoption, but the effects are small (less than one percent), and not significantly different from zero. Conversely, the negative coefficient on percent of neighbors with CT-scanners indicates that more specific competition in providing CT-scans reduced the likelihood of adoption post-PPS. Again, the effect is small and statistically insignificant.

A hospital's total margin in TEFRA had a statistically significant effect on the likelihood of adoption between TEFRA and PPS 3. An increase in the margin from 0 to 10 percent is estimated to increase the likelihood of adoption by about 2 percent. Medicare casemix has a strong impact on likelihood of adoption both pre- and post-PPS. A change from an index of .5 to 1.5 (roughly the range of the index across hospitals) is estimated to increase the probability of adoption in both periods by about 45 percent. The percent of complexity-enhancing services offerred in TEFRA also has a strong effect on the probability of adoption by PPS 3.** For example, a hospital that offerred 80 percent of services in TEFRA had a 32 percent greater chance of adopting by PPS 3 than a hospital that offerred 30 percent of the services in TEFRA.

Among other hospital-specific variables, bedsize has a very strong effect on the likelihood of adopting. Pre-PPS, the effect is especially strong above 100 beds, but levels off above 300 beds. Post-PPS, the bedsize effect is relatively stronger among smaller hospitals as diffusion activity shifted from the larger hospitals to them. Apparently, virtually all hospitals of more than 400 beds had adopted by TEFRA. Controlling for bedsize, teaching status is insignificantly related to adoption, except for a negative coefficient on minor teaching post-PPS. Ceteris paribus, government or for-profit control, percent change in the number of discharges post-PPS, and membership in a multihospital system are statistically insignificantly related to adoption pre- or post-PPS.

Among area characteristics, per capita income has the expected positive effect, although it is significantly different from zero only pre-PPS. Population density has a significant negative coefficient, perhaps for the reasons hypothesized in the preceeding section. Holding population density constant, urbanicity has no statistically significant effect. Physicians per capita is also insignificant. Hospital wages has an unexpected positive, significant coefficient in the pre-PPS regression. Areas with higher costs (wages) were more likely to adopt pre-PPS. This variable is highly correlated with urbanicity and population density and may be capturing some of the effects of those variables.

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*The Herfindahl index varies between 0 and 1 with 1 being monopoly and zero the limit of no concentration. Thus, a negative coefficient means that less concentration is associated with a greater likelihood of adoption.

**Dropping this variable from the equation did not have major effects on other coefficients.

Table 11 presents analogous results for NMR. The pre-PPS regression is much less successful in explaining the adoption of NMR by the TEFRA year than the pre-PPS CT-scan regression is in explaining adoption of CT-scan. The R-squares are 50 percent for CT scan and 2.6 percent for NMR. Only two coefficients are significant at the 5 percent level in the NMR regression.* Major teaching hospitals were 8.4 percent more likely to have NMR in the TEFRA year than nonteaching hospitals. An increase in the number of physicians per capita from 100 to 500 per 100,000 population is associated with about a 7 percent increase in a hospital's likelihood of having NMR in TEFRA. Interestingly, both teaching status and physicians per capita are insignificant in the CT-scan equation, while bedsize and casemix, which are strong predictors of pre-PPS adoption in the CT-scan equation, are insignificant in the NMR equation. Over this period, NMR was apparently an experimental technology strongly associated with major teaching hospitals and physician demand, while CT-scan had become more routinely associated with larger hospitals and those treating a more difficult mix of cases.

Medicare dependence has a positive sign in the pre-PPS NMR equation, which changes to negative in the post-PPS regression, but neither is significantly different from zero. PPS GAIN is also not significantly different from zero in the post-PPS equation. Percent of complexity-enhancing services offerred in the TEFRA year is by far the most important variable in the post-PPS regression. An increase from 30 to 80 percent of services offered raises the likelihood of having NMR in PPS 3 by about 14 percent. The addition of this variable may be why teaching status is insignificant in the post-PPS regression.

We now turn to the regressions explaining pre- and post-PPS adoption or disadoption of two categories of hospital services. Table 12 presents results for counts of complexity-enhancing services. The most important variables by far in the pre-PPS equation are casemix and bedsize. A one-unit increase in the Medicare casemix index is associated with about five more complexity-enhancing services (out of 13 total). Fifty to 99 bed hospitals have about one more service than under 50 bed hospitals, while over 400 bed hospitals have more than seven more services. Holding bedsize constant, major teaching hospitals have one additional complexity-enhancing service. Proprietary hospitals have a statistically significant .17 fewer services. Members of multihospital systems have a nearly statistically significant .10 more services. Competition has little effect on the number of complexity-enhancing services.

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*We hope to improve the precision of these estimates through probit techniques. Probit should be especially fruitful here because so few hospitals had adopted by TEFRA (about 3 percent).

Complete Medicare dependence is associated with about .4 more services pre-PPS than no Medicare dependence, and with the adoption of about .5 more services post-PPS. Neither coefficient is quite statistically significant. Surprisingly, the PPS GAIN coefficient is negative and statistically significant post-PPS. The effect is fairly small, however. _Ceteris paribus_, no predicted financial gain from PPS is associated with adopting about .2 more services post-PPS than a 5 percent gain (roughly the 90th percentile of GAIN).

The reasons for a negative, significant GAIN coefficient are unclear.* Perhaps hospitals that were under greater financial pressure from PPS added more services in an attempt to attract business and improve their financial position. Hospitals predicted to gain from PPS were short-stay, low-cost institutions. It may be that for unclear market specialization or other strategic competitive reasons that these hospitals tended to adopt fewer services post-PPS.

Among other variables in the post-PPS equation, casemix and bedsize continue to be important determinants of adoption, but are not as dominant as in the pre-PPS equation. As expected, the percent of services offerred in TEFRA has a strong negative effect on the number of services adopted post-PPS, while the square of this variable is positive. Proprietary hospitals continue to adopt fewer services post-PPS, while the teaching coefficients become statistically insignificant. Hospitals whose discharges fell by less than -30 percent adopted .23 to .36 more services than hospitals whose discharges dropped by more than 30 percent. Population density continues to be negatively associated with adoption post-PPS, but hospital wages, which had a surprising, strong positive association with number of services pre-PPS, becomes insignificant post-PPS.

In the pre-PPS outpatient services regression (Table 13), casemix and bedsize are important variables, but they are not as dominant as in the complexity-enhancing services equation. For instance, greater than 400 bed hospitals have more than seven more complexity-enhancing services than under 50 bed hospitals, but only about 1.6 more outpatient services.** Proprietary hospitals have about .5 fewer outpatient services than voluntary hospitals as compared to .17 fewer complexity-enhancing services. Government hospitals have .2 fewer outpatient services, which is statistically significant, while their number of complexity-enhancing services is not statistically different from voluntary hospitals. Minor teaching hospitals have more outpatient services than complexity-enhancing services relative to nonteaching hospitals, while major teaching hospitals have relatively more complexity-enhancing services. Membership in a multihospital system is again associated with .1 more services.

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*The GAIN variable is not highly correlated with any of the other independent variables, so it is unlikely that dropping other variables from the equation would change its sign.

**There are 13 total complexity-enhancing services and 10 total outpatient services.

The competition variables are more important in determining the number of outpatient services than complexity-enhancing ones. One more outpatient service, on average, among neighboring hospitals is associated with about .1 more outpatient services in the sample hospital, which is statistically significant. This is consistent either with a competition effect or with unmeasured greater demand for outpatient services in certain areas. The Herfindahl index coefficient, on the other hand, indicates that more outpatient services are associated with greater concentration. The coefficient is nearly significant at the 10 percent level. Specific competition in outpatient services seems to promote adoption, while more general potential competition may retard it.

Medicare dependence is significantly negatively associated with the number of outpatient services pre-PPS, in contrast to a positive, insignificant effect on the number of complexity-enhancing services. Complete Medicare dependence is associated with about .8 fewer outpatient services than no Medicare dependence. Post-PPS, Medicare dependence has no statistically significant effect on outpatient service adoption. PPS GAIN again retards post-PPS service adoption, with a coefficient of similar magnitude to the complexity-enhancing services regression.

Among other variables in the post-PPS regression, percent of outpatient services offered in TEFRA has the expected strong, negative effect. Bedsize continues to have a positive effect on adoption, while government and for profit hospitals continued to add fewer services. Per capita income is positively associated with the number of outpatient services added.

6.0 CONCLUSIONS

Without question, U.S. short-term general hospitals have undertaken major changes in the way they diagnose and treat patients since the inception of PPS. Some of these changes have been dramatically confirmed in this paper. Hospitals have pushed rapidly into alternative uses of beds and services--particularly on a subacute or ambulatory basis. Rehab, swing, and alcohol/chemical dependency beds have appeared in hospitals and cities where they were absent. The percent of hospitals with home care programs has tripled in just four years and the percent with an organized outpatient department has doubled. This is true even among average sized rural hospitals even though many have had financial troubles due to declining inpatient volumes.

All of these changes reflect the industry's rapid response to the very clear incentives of PPS (and other third party initiatives) to diversify into non-acute forms of care. These incentives either follow directly from the need to discharge patients sooner and treat on an ambulatory basis or indirectly from a desire to generate new revenue sources from lost inpatient volumes.

Seemingly unaffected has been the diffusion of costly, complexity-expanding services such as open heart surgery, CT scanners, and nuclear magnetic resonance. The early concerns that fixed payment would discourage adoption of these life-saving technologies are not supported by either the descriptive or the multivariate results reported above. The usual hospital and area characteristics like bedsize, teaching status, profitability, and casemix severity, dominate any statistical explanations of diffusion levels. PPS-related variables play little role; indeed, expected losers under PPS were found to be more likely to adopt new complex services, holding bedsize, profits, volume changes, and other variables constant.

There are several possible explanations for a lack of a PPS-induced slowdown in the adoption of expensive services. First, PPS excluded capital costs, which continued to be paid on a passthrough basis.

Second, many hospitals enjoyed unexpected windfall profits under PPS due do DRG upcoding, improved productivity, and shifts in the site of diagnostic and therapeutic care.

Third, PPS heightened the interhospital competition for patients, which is manifested in part through the range of complex services offerred. Hospitals could no longer be indifferent to the adoption of a CT scanner, for example, by a competitor because of the implications it could have for admissions and inpatient revenues. This competitive effect is true even for the most complex and costly of services such as open heart surgery.

And fourth, it is also possible that the adoption decision for several of these new technologies was made prior to PPS and could not be revoked. In this case, the continued adoption of these and other as yet undeveloped technologies is still a question mark. That hospitals continued to adopt these critical services in the infancy of DRG fixed payment rates does not guarantee they will do so five or ten years from now. Nevertheless, the fact that PPS did not lead to an immediate halt in their diffusion is reassuring and possibly a bit encouraging for the future.

TABLE 1

TRENDS IN ACUTE, INTENSIVE CARE, AND SUBACUTE BEDS, 1982, 1984, AND 1986

	1982		1984		1986	
	Percent Hospitals with Bed Type	Average Number of Beds	Percent Hospitals with Bed Type	Average Number of Beds	Percent Hospitals with Bed Type	Average Number of Beds
BED ACCOMMODATION						
ACUTE						
Pediatric	49.7%	17.3	48.5%	16.8	46.4%	16.3
Psychiatric	19.9	31.4	20.7	32.2	22.1	33.0
Obstetric	69.2	15.5	69.8	15.6	68.3	16.0
Alcohol/Chemical Dependency	7.3	24.8	9.9	24.8	14.1	24.0
ICU						
Medical-Surgical ICU	72.6	9.6	76.6	9.8	74.3	10.5
Cardiac ICU	27.8	8.3	26.4	8.7	21.7	9.3
Neonatal ICU	8.0	14.3	9.6	14.6	10.4	14.9
Pediatric ICU	3.4	6.2	4.1	6.1	4.6	7.5
Burn Care	2.2	9.9	2.2	9.6	2.3	10.2
SUBACUTE CARE BEDS	14.8	59.2	15.0	57.5	18.7	55.1
OTHER BED TYPES						
Rehabilitation	4.7	26.7	6.6	26.0	9.4	25.7
Hospice	0.7	8.6	1.2	6.9	1.7	7.1
Alcohol/Chemical, subacute	.	.	2.0	22.1	2.4	21.7
Swing Beds	1.1	6.5	5.9	12.7	8.5	17.7

Definitions: **SUBACUTE** includes SNF, psychiatric, and other long-term care; mental retardation; sheltered care; self care; and other subacute care not included in OTHER BED TYPES in table.

Source: AHA Annual Survey tapes, 1982-86.

TABLE 2

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING COMPLEXITY-EXPANDING SERVICES, 1981-86

SERVICE	1981	1982	1983	1984	1985	1986
Open-Heart Surgery	10.2%	10.8%	11.1%	11.4%	12.1%	13.1%
Cardiac Catheterization	15.3	16.1	16.5	17.1	18.1	19.7
Hemodialysis	23.3	22.1	23.6	24.7	26.3	26.4
Diagnostic Radioisotope	63.0	62.9	66.3	67.4	68.1	63.8
Megavoltage Radiation Therapy	15.6	15.8	15.7	15.7	16.5	16.4
Radioactive Inplants	22.4	22.2	22.5	23.3	24.7	23.5
Therapeutic Radioisotope	23.4	23.3	23.0	23.6	24.2	23.3
X-Ray Radiation Therapy	19.9	19.3	17.1	17.1	17.7	17.1
Diagnostic Ultrasound	71.4	72.9	78.5	82.2	85.6	86.1
Nuclear Magnetic Resonance	.	.	3.1	3.4	5.0	6.6
C.T. Scanner	.	30.9	38.5	46.8	55.2	59.2
Organ Transplant	5.3	5.0	5.2	5.2	5.3	4.9

Source: AHA Annual Survey tapes, 1981-86.

TABLE 3

TRENDS IN COMPLEXITY-EXPANDING SERVICES BY HOSPITAL CHARACTERISTIC, 1981-1986

	PERCENT OF SERVICES PROVIDED*						
CHARACTERISTIC	1981	1982	1983	1984	1985	1986	Total Percent Change 1981-86
All Hospitals	27.0%	27.4%	26.8%	28.1%	29.9%	30.0%	11.1%
Region							
New England	32.8	32.0	31.0	31.9	33.9	33.7	2.7
MidAtlantic	36.0	37.1	36.4	37.4	39.1	39.0	8.3
South Atlantic	29.5	31.0	28.8	30.1	31.5	31.7	7.5
ENC	31.4	31.3	31.2	32.6	34.7	34.3	9.2
ESC	22.1	23.0	22.8	24.2	26.0	27.6	24.9
WNC	19.9	19.4	19.6	20.8	22.7	22.8	14.6
WSC	23.4	24.3	23.4	25.4	27.1	25.9	10.7
Mountain	21.1	20.6	20.1	22.6	23.9	25.3	19.9
Pacific	33.3	33.9	33.5	34.1	36.3	37.7	13.2
Teaching Status							
Non Teaching	20.4	20.7	20.7	22.2	23.8	24.2	18.6
Other Teaching	55.4	56.4	53.1	54.6	56.0	57.0	2.9
Major Teaching	78.7	78.4	71.4	72.5	74.7	73.4	-6.8
Rural	14.7	14.3	14.7	15.9	17.4	17.3	17.7
< 50 Beds	5.9	5.2	6.4	7.4	8.4	9.0	52.5
50-99 Beds	13.1	12.8	13.7	15.6	18.0	18.2	38.9
100-169 Beds	25.1	24.6	24.1	26.2	28.0	29.1	15.9
> 169 Beds	43.3	45.0	42.1	43.9	46.7	45.6	5.3
Urban	39.6	40.8	39.3	40.7	42.9	43.1	8.8
< 100 Beds	12.3	12.3	13.3	15.3	16.2	16.7	35.8
100-199 Beds	26.1	25.9	26.7	28.7	31.2	31.1	19.1
200-299 Beds	44.3	46.0	42.9	44.9	46.8	48.6	9.7
300-404 Beds	57.1	59.0	56.1	56.8	60.2	61.4	7.5
405-504 Beds	68.5	71.2	66.4	68.0	71.6	74.5	8.8
> 504 Beds	85.8	86.7	79.2	80.7	83.5	84.0	-2.1
Control							
Voluntary	32.7	33.3	32.1	33.3	35.3	35.6	8.9
Proprietary	23.0	21.8	22.5	24.7	26.3	26.8	16.5
State and Local	18.3	18.8	18.7	19.8	21.4	20.9	14.7

*Figures in table are unweighted percentages of 12 complexity-expanding services directly provided by hospitals. See Table 2 for list.

Source: AHA Annual Surveys, 1981-86.

TABLE 4

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING SUPPORT SERVICES, 1982-86*

SUPPORT SERVICE	1982	1984	1986
Blood Bank	70.9%	72.0%	71.9%
Histopathology	64.1	64.0	62.1
Physical Therapy	86.9	89.8	89.6
Occupational Therapy	32.8	37.2	43.2
Recreational Therapy	18.9	21.2	25.0
Respiratory Therapy	91.7	94.0	92.6
Speech Pathology	34.0	41.2	47.9

Source: AHA Annual Survey tapes, 1982-86.

TABLE 5

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING OUTPATIENT SERVICES, 1982-86

	1982	1984	1986
OUTPATIENT SERVICE			
Emergency Department	94.9%	96.3%	95.5%
Outpatient Department	38.3	46.3	63.0
Alcohol/Chemical Outpatient	10.8	12.8	16.5
Psychiatric Emergency Services	27.4	29.1	30.7
Psychiatric Outpatient Services	11.2	12.2	14.1
Occupational Therapy	32.8	37.2	43.2
Rehabilitation Service	29.4	33.2	35.5
Home Care Program	12.2	22.2	35.4
Ambulatory Surgical Service	86.3	91.2	93.8
Hospice	8.0	10.4	14.3

Source: AHA Annual Survey tapes, 1982-86.

TABLE 6

TRENDS IN OUTPATIENT SERVICES BY HOSPITAL CHARACTERISTIC, 1982-1986*

CHARACTERISTIC	PERCENT OF SERVICES PROVIDED 1982	 1984	 1986
All Hospitals	35.4%	39.3%	44.3%
Region			
New England	51.1%	53.4%	54.4%
MidAtlantic	48.1	50.6	54.2
South Atlantic	32.4	35.9	40.0
ENC	40.6	45.1	50.5
ESC	28.6	31.9	36.7
WNC	34.6	39.8	45.3
WSC	28.2	32.1	38.1
Mountain	34.5	38.7	45.3
Pacific	37.9	41.6	47.4
Teaching Status			
Non Teaching	31.6	35.6	40.9
Other Teaching	52.5	56.9	61.0
Major Teaching	59.1	61.1	64.8
Rural	29.0	32.5	38.0
< 50 Beds	24.4	27.4	33.0
50-99 Beds	28.3	32.0	38.4
100-169 Beds	34.8	39.4	45.6
> 169 Beds	43.1	48.6	55.0
Urban	41.9	46.3	50.8
< 100 Beds	26.2	29.9	34.8
100-199 Beds	35.1	40.4	45.7
200-299 Beds	46.0	49.7	54.9
300-404 Beds	52.0	57.3	61.9
405-504 Beds	55.7	61.4	64.9
> 504 Beds	63.1	65.8	70.8
Control			
Voluntary	40.1	44.3	49.4
Proprietary	27.9	32.8	37.0
State and Local	29.6	32.7	38.0

*Figures in table are unweighted percentage of eight outpatient services: emergency, outpatient dept., alcohol/chemical dependency, psychiatric outpatient, rehabilitation, home care, ambulatory surgery, and hospice.

Source: AHA Annual Survey tapes, 1982-86.

TABLE 9

DISTRIBUTION OF MSAs BY THE NUMBER OF COMMUNITY OUTPATIENT SERVICES IN THE MSA, 1982-86

Number of Units In MSA	ORGANIZED OUTPATIENT DEPT.			EMERGENCY DEPARTMENT			AMBULATORY SURGICAL SERVICE			PSYCHIATRIC OUT-PATIENT SERVICES		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	33	26	9	2	1	1	2	1	2	141	130	111
1	83	56	57	26	24	23	22	21	19	89	95	108
2	61	72	54	68	65	63	68	63	62	44	47	48
3	45	43	56	44	38	46	44	41	49	12	15	14
4	26	31	36	40	46	47	46	42	41	14	13	12
5	15	27	22	35	36	30	30	36	31	7	8	10
6-10	33	36	50	62	57	58	63	63	63	10	10	18
11+	30	37	46	49	61	62	51	61	63	9	10	9

Number of Units In MSA	HOME CARE PROGRAM			HOSPICE			ALCOHOL/CHEMICAL DEPENDENCY			REHABILITATION SERVICE		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	173	110	57	180	153	124	151	122	99	58	43	35
1	81	97	102	84	95	107	99	107	108	82	80	77
2	40	47	54	33	36	41	31	47	55	71	75	67
3	12	30	46	9	21	23	17	16	21	40	40	55
4	6	6	17	8	4	14	11	11	9	16	19	23
5	3	10	16	1	7	6	3	8	9	11	15	13
6-10	3	19	17	7	7	10	5	9	19	23	29	29
11+	8	9	21	4	5	5	9	8	10	25	27	31

Note: The total number of MSAs in 1982 was 326, with 328 in 1984 and 330 in 1986.

TABLE 7

DISTRIBUTION OF MSAs BY THE NUMBER OF BED ACCOMMODATIONS OF A SELECTED TYPE, 1982-86

Number of Units in MSA	MEDICAL/SURGICAL INTENSIVE CARE BEDS			CARDIAC INTENSIVE CARE BEDS			NEONATAL INTENSIVE CARE BEDS		
	Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	6	1	6	63	61	65	146	132	111
1	30	27	25	83	81	103	105	106	127
2	65	63	67	63	75	64	40	40	37
3	54	51	51	36	28	21	15	25	20
4	43	42	45	19	15	19	9	10	12
5	24	32	27	12	14	10	3	6	9
6-10	58	53	51	25	33	30	4	5	10
11+	46	59	58	25	21	18	4	4	4

Number of Units in MSA	BURN CARE BEDS			REHABILITATION CARE BEDS			ALCOHOL/CHEMICAL DEPENDENCY CARE BEDS		
	Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	233	232	229	209	176	145	180	328	330
1	79	78	84	74	96	101	103	0	0
2	10	14	11	25	29	38	20	0	0
3	0	3	5	5	9	16	7	0	0
4	2	0	0	5	5	10	3	0	0
5	2	1	1	2	5	5	4	0	0
6-10	.	.	.	4	5	10	5	0	0
11+	.	.	.	2	3	5	4	0	0

Note: The total number of MSAs in 1982 was 326, with 328 in 1984 and 330 in 1986.

TABLE 8

DISTRIBUTION OF MSAs BY THE NUMBER OF COMPLEXITY-EXPANDING SERVICES, 1982-86

Number of Units in MSA	OPEN-HEART SURGERY			CARDIAC CATHETERIZATION			HEMODIALYSIS			ORGAN TRANSPLANT		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	134	124	114	87	79	56	40	34	31	205	200	209
1	86	92	90	104	101	105	124	114	110	67	73	68
2	41	45	50	48	52	61	70	66	74	29	26	21
3	20	24	28	31	30	37	27	37	34	8	17	14
4	15	10	6	11	17	16	19	19	17	6	2	7
5	9	13	15	11	11	9	4	11	13	5	3	3
6-10	17	14	20	20	25	31	20	22	23	4	7	7
11+	4	6	7	14	13	15	22	25	28	2	0	1

Number of Units in MSA	MEGAVOLTAGE RADIATION THERAPY			DIAGNOSTIC ULTRASOUND FACILITY			NUCLEAR MAGNETIC RESONANCE FACILITY			C.T. SCANNER		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	63	55	50	2	0	1	319	262	201	14	4	1
1	149	154	160	28	31	23	5	45	64	96	54	44
2	42	43	44	78	64	68	2	13	28	92	85	79
3	25	28	20	51	45	43	0	5	10	36	52	51
4	8	8	11	43	40	43	0	1	12	22	37	32
5	11	9	9	20	31	33	0	0	9	10	15	25
6-10	18	20	27	56	59	61	0	2	5	23	33	47
11+	10	11	9	48	58	58	0	0	1	33	48	51

Note: The total number of MSAs in 1982 was 32, with 328 in 1984 and 330 in 1986.

TABLE 10

DETERMINANTS OF HOSPITAL ADOPTION OF CT-SCANNERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.71	-8.18	-.44	-1.74
PPS Gain	--	--	-.051	-.10
Medicare Dependence[b]	.12	2.28	.10	.82
Herfindahl[b]	-.018	-.71	-.064	-1.17
Percent of Other County Hospitals with CT-SCAN[b]	--	--	-.00049	-.88
Total Margin[b]	--	--	.21	2.01
Medicare Casemix[b]	.46	6.58	.44	2.33
Percent Complexity-Enhancing Services[b]	--	--	.64	4.60
Member Multi-Hospital System[b]	-.011	-.92	-.017	-.59
Beds[b,c]				
50-99	.099	6.50	.19	6.00
100-199	.40	23.14	.32	7.16
200-299	.66	29.29	.34	4.13
300-399	.77	26.97	.37	1.84
>400	.78	25.26	.013	.04
Control[b,d]				
Government	-.017	-1.31	.0039	.14
For-Profit	.0023	.14	.015	.35
Teaching Status[b,e]				
Minor Teaching	-.0075	-.39	-.18	-2.51
Major Teaching	.000072	.002	-.16	-.61

TABLE 10 (continued)

DETERMINANTS OF HOSPITAL ADOPTION OF CT-SCANNERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.045	.88
10%≤ and >-10%	--	--	.041	1.11
-10%≤ and >-30%	--	--	.010	.35
Area Characteristics[b]				
Per Capita Income $x10^{-6}$	7.4	2.23	9.1	1.15
Population Density $x10^{-5}$	-1.3	-3.18	-4.8	-2.49
Hospital Wages	.24	3.64	.045	.22
Urban	-.0078	-.37	-.027	-.50
MDs Per Capita	6.72	.89	.35	.02
R^2	.50		.18	
F	230.70		10.90	
N	4222		1271	

---

[a] Sample is limited to TEFRA nonadopters.

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 11

DETERMINANTS OF URBAN HOSPITAL ADOPTION OF NUCLEAR MAGNETIC RESONANCE IMAGERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.019	-.33	-.24	-1.43
PPS Gain	--	--	-.24	-.51
Medicare Dependence[b]	.049	1.26	-.093	-.91
Herfindahl[b]	-.050	-1.68	-.067	-.98
Percent of Country Hospitals with NMR[b]	--	--	-.00082	-.64
Total Margin[b]	--	--	-.0078	-.09
Medicare Casemix[b]	.058	1.33	.16	1.37
Percent Complexity-Enhancing Services[b]	--	--	.28	4.08
Member Multi-Hospital System[b]	.0024	.28	-.0035	-.16
Beds[b,c]				
50-99	-.0047	-.28	-.044	-1.02
100-199	-.0088	-.54	-.045	-1.00
200-299	-.020	-1.13	-.044	-.86
300-399	-.011	-.58	-.07	-1.26
>400	.018	.089	.039	.62
Control[b,d]				
Government	-.00048	-.04	-.053	-1.87
For-Profit	.0060	.54	.027	.97
Teaching Status[b,e]				
Minor Teaching	-.0034	-.33	.0010	.04
Major Teaching	.084	3.75	-.028	-.40

TABLE 11 (continued)

DETERMINANTS OF URBAN HOSPITAL ADOPTION OF NUCLEAR MAGNETIC RESONANCE IMAGERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.023	.62
10%≤ and >-10%	--	--	.057	1.88
-10%≤ and >-30%	--	--	.0041	.15
Area Characteristics[b]				
Per Capita Income x10^{-6}	-2.9	-1.21	-2.2	-.36
Population Density x10^{-5}	-.42	-1.89	-2.5	-3.07
Hospital Wages	-.0040	-.10	.13	1.18
MDs Per Capita	13.71	3.19	2.64	.27
R^2	.026		.14	
F	3.13		4.96	
N	1995		750	

---

[a] Sample is limited to TEFRA nonadopters.

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 12

DETERMINANTS OF NUMBER OF HOSPITAL COMPLEXITY-ENHANCING SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-4.57	-10.53	-.24	-.45
PPS Gain	--	--	-4.33	-3.32
Medicare Dependence^{b}	.38	1.42	.48	1.62
Herfindahl^{b}	-.0024	-.02	-.081	-.60
Average Number Services, Neighboring Hospitals^{b}	.0099	.67	.018	1.18
Total Margin^{b}	--	--	.40	1.62
Medicare Casemix^{b}	4.97	14.23	.93	2.26
Member Multi-Hospital System^{b}	.10	1.71	.012	.18
Percent Complexity-Enhancing Services^{b}	--	--	-6.72	-13.13
Square of Percent Complexity-Enhancing Services^{b}	--	--	4.23	8.01
Beds^{b,c}				
50-99	1.14	14.89	.60	6.96
100-199	2.84	33.13	.92	8.27
200-299	4.61	41.25	1.24	8.32
300-399	5.80	41.64	1.28	6.98
>400	7.38	48.39	1.43	6.98
Control^{b,d}				
Government	-.052	-0.79	-.056	-.82
For-Profit	-.17	-2.04	-.17	-1.80
Teaching Status^{b,e}				
Minor Teaching	.27	2.88	.019	.18
Major Teaching	1.01	4.99	-.33	-1.15

TABLE 12 (continued)

DETERMINANTS OF NUMBER OF HOSPITAL COMPLEXITY-ENHANCING SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.34	3.02
10%≤ and >-10%	--	--	.36	4.16
-10%≤ and >-30%	--	--	.23	3.18
Area Characteristics[b]				
Per Capita Income $\times 10^{-6}$	-6.2	-.38	10.05	.56
Population Density $\times 10^{-5}$	-6.0	-2.97	-7.09	-2.09
Hospital Wages	1.54	4.81	.061	.15
Urban	-.23	-2.19	.073	.64
MDs Per Capita	65.31	1.65	-27.52	-.73
R^2	.74		.15	
F	572.1		11.6	
N	3926		1746	

---

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 13

DETERMINANTS OF NUMBER OF HOSPITAL OUTPATIENT SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.13	-.37	2.05	3.45
PPS Gain	--	--	-4.52	-3.10
Medicare Dependence[b]	-.81	-3.77	.19	.58
Herfindahl[b]	.18	1.61	.25	1.58
Average Number Services, Neighboring Hospitals[b]	.11	6.49	.030	1.30
Total Margin[b]	--	--	-.029	-.11
Medicare Casemix[b]	2.25	7.99	-.61	-1.35
Member Multi-Hospital System[b]	.10	2.04	0.37	.50
Percent Outpatient Services	--	--	-4.57	-6.23
Square of Percent Outpatient Services	--	--	.30	.35
Beds[b,e]				
50-99	.27	4.41	.077	.84
100-199	.61	8.76	.26	2.47
200-299	1.03	11.43	.39	2.79
300-399	1.40	12.39	.50	2.87
>400	1.56	12.60	.87	4.69
Control[b,d]				
Government	-.21	-3.91	-.21	-2.75
For-Profit	-.47	-6.78	-.28	-2.63
Teaching Status[b,e]				
Minor Teaching	.49	6.36	.13	1.06
Major Teaching	.57	3.50	.47	1.44

TABLE 13 (continued)

DETERMINANTS OF NUMBER OF HOSPITAL OUTPATIENT SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.082	.64
10%≤ and >-10%	--	--	.032	.34
-10%≤ and >-30%	--	--	.095	1.15
Area Characteristics[b]				
Per Capita Income $x10^{-6}$	24.40	1.82	57.8	2.86
Population Density $x10^{-5}$	-2.18	-1.33	-4.04	-1.06
Hospital Wages	.36	1.40	-.16	-.35
Urban	-.12	-1.39	.16	1.24
MDs Per Capita	24.84	.81	-53.17	-1.30
R^2	.33		.17	
F	102.4		13.5	
N	3933		1749	

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[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

REFERENCES

Berry, R.E., Jr. "On Grouping Hospitals for Economic Analysis." Inquiry, 10, December 1973, 5-12.

Russell, Louise B. "Prospective reimbursement and new hospital services." Journal of Health Economics, 3, No. 1, 1984, 77-81.

Russell, Louise B. Technology in Hospitals: Medical Advances and Their Diffusion. Washington, D.C.:The Brookings Institution, 1979.

Romeo, A., J. Wagner, and R. Lee, "Prospective Reimbursement and the Diffusion of New Technologies in Hospitals," Journal of Health Economics 3(1984): 1-24.

Hillman, B., "Government Health Policy and the Diffusion of New Medical Devices," Health Services Research 21:5 (Dec. 1986): 681-711.

Luft, H. et al., "The Role of Specialized Clinical Services in Competition Among Hospitals," Inquiry 23 (Spring 1986): 83-94.

Shortell, S. et al., "Diversification of Health Care Services: The Effects of Ownership, Environment, and Strategy," in Advances in Health Economics and Health Services Research 7 (JAI Press, 1987): 3-40.

Lee, R. and D. Waldman, "The Diffusion of Inovations in Hospitals: Some Econometric Considerations," Journal of Health Economics 4 (985): 373-380.

Maddala, G., Limited-Dependent and Qualitative Variables in Econometrics (Cambridge University Press, 1983).

Feder, J., J. Hadley, and S. Zuckerman, "How Did Medicare's Prospective Payment System Affect Hospitals?", New England Journal of Medicine 317:14 (October 1, 1987): 8678-873.

Love, J. et al., "The Decision to Seek an Exemption from PPS," Journal of Health Economics 7(1988): 165-171.

Bowen, Otis R., M.D., Secretary Department of Health and Human Services. Report to Congress on: The Impact of the Medicare Hospital Prospective Payment System, 1986 Annual Report.

Hendricks, Ann, Jerry Cromwell, et al., "The Prospective Payment System's Impacts or Rural Hospital," Needham, MA, The Center for Health Economics Research, September 1988.

Prospective Payment Assessment Commission. Medicare Prospective Payment and the American Health Care System: Report to Congress. June 1988.

Prospective Payment Assessment Commission. Report and Recommendcations to the Secretary, U.S. Department of Health and Human Services. April 1986.

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THE IMPACT OF MEDICARE'S PROSPECTIVE PAYMENT SYSTEM ON TECHNOLOGY DIFFUSION

Working Paper

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THE IMPACT OF MEDICARE'S PROSPECTIVE PAYMENT SYSTEM ON TECHNOLOGY DIFFUSION

1.0 INTRODUCTION

In the Fall of 1983, HCFA began implementing a novel payment system for hospitals. Rates were determined based on average costs within approximately 470 Diagnosis Related Groups (DRGs) and paid upon discharge without any year-end settlements for additional costs. Not all costs were covered under the fixed rates. Capital costs, mainly depreciation and interest, continued to be reimbursed on a passthrough basis, although the Congress has authorized rollbacks in payments (currently 15 percent).

The industry's responses to the system were generally in the expected direction, but much more aggressive than anyone had predicted. The easiest way hospitals could cut costs would be to shorten stays, and Medicare lengths of stay fell almost 10 percent in the first year, followed by another 6 percent in year two (DHHS, 1986, Table 3-4). Administrators also began shifting the site of care to the ambulatory setting, either to reduce costs or to generate extra revenues in their outpatient facilities that were still reimbursed based on incurred costs.

All of these incentives and trends support a hypothesis of less diffusion and adoption of costly inpatient ancillary services. Prospective payment for operating expenses greatly increases the financial risk of underutilizing cost-increasing technologies. In particular, profits are automatically reduced if a hospital uses a particular piece of equipment in the treatment of a Medicare patient because the final payment is fixed. Moreover, the incentive to shift the site of care should lead to less hospital adoption and more diffusion to noninstitutional settings. And finally, the unexpectedly large volume declines should make new investments even riskier in terms of uncovered payments.

On the other hand, other factors could produce an opposite conclusion. The fact that capital costs have been treated as a passthrough to date encourages hospitals to substitute capital for labor. How much substitution is possible depends upon the type of equipment. Computers can easily substitute for labor in a variety of functions, but CAT scanners may require more complementary personnel to manage, administer, and interpret the procedure.

We also know that hospital profits in the first three years of PPS were at historical highs (ProPAC, 1988, p.46). This seems to have been a result of higher than expected payments per case and cost cutting and site shifting. Large windfall profits produce substantial "income effects" that may offset any negative "price effects" inherent in greater investment risk under fixed payment. Hospitals simply had a lot of reserves burning a hole in their pockets.

Finally, now that hospitals are being paid (by Medicare) only when they admit patients, they are no longer financially indifferent to interhospital rivalry. Whereas under cost-based reimbursement hospitals could aggressively compete for patients or not, without worrying about covering their sizable fixed costs, now they must compete or see payments fall accordingly. This places a premium on projecting a positive community image to attract patients, which in turn revolves around having the latest technologies. This suggests that the effects of declining volumes on adoption are ambiguous. On the one hand, they discourage the adoption of services due to the greater utilization risk, while on the other hand they force hospitals to adopt certain services faster than they might otherwise have in order to avoid risking an unacceptable drop in community support and possible bankruptcy.

The purpose of this paper is to explore the relationship between PPS and the diffusion of complexity-expanding, support, and outpatient services; to see if PPS in its initial phase really discouraged the adoption of new services and technologies. If it did, we would be able to say a little more about how hospitals behave when actually faced with fixed or declining budgets. Slower adoption rates could also be indicative of a potential problem with prospective payment; namely, the suppression of beneficial technical change.

We will also examine the growth in outpatient services to see if hospitals have been competing by reaching out into the community with new services or by following up patients who are being discharged earlier than in the past. Unfortunately, we will not be able to say whether any growth in outpatient activity is due to PPS site-of-care incentives or to rivalrous behavior, but it is important to lay out the facts as we now know them.

The paper will also address the question of access to services in a limited way. This is done by asking a couple of key questions. Are rural hospitals adopting complexity-expanding and outpatient services at rates similar to urban hospitals? Are new technologies diffusing to new MSAs or just "piling up" in cities already oversupplied?

The paper includes both descriptive and multivariate research. Descriptive trends indicate how much diffusion of complex versus outpatient services has occurred in the last few years while multivariate analysis is used to isolate PPS effects from other underlying causes.

2.0 DATA SOURCES

Two data sources are used for the study. The main source is the AHA Annual Survey of Hospitals for the 1980-86 period. This survey ask hospitals whether they provide at their own institutions a list of 50-60 individual services, or whether it is available in a shared arrangement with another local institution. We collapsed the choices to a 0,1 variable indicating whether the service was provided by the particular institution.

The annual survey also ask hospitals about 25 different types of bed accommodations, e.g., pediatric, neonatal ICU, rehab. Thus, we know how many beds in each accommodation the hospital had set up and staffed on the last day of its fiscal year. Several of these bed categories are also reported as a 0,1 service, but we prefer the bed data for two reasons. First, they are more indicative of a hospital actually providing the service on-site rather than through some referral arrangement. And second, the number of beds provides a measure of the depth of commitment to the service, which is unfortunately lacking in the rest of the facility and service data.

Given our interest in PPS effects on diffusion, we first subsetted the universe of short-term general hospitals to those generally eligible for PPS: namely general medical and surgical; obstetrics and gynecology; eye, ear, nose, and throat; and orthopedic. Specialized hospitals designated as psychiatric, rehabilitation, and chronic disease were some of the types of hospitals excluded from our analysis. This data set consisted of approximately 5,600 hospitals per year. We further eliminated federal hospitals and those in the four waivered states (NJ, MA, MD, NY), leaving a data set that consisted of 54 percent voluntary, 15 percent proprietary, and 31 percent state and local hospitals. The resulting sample used for our analysis contained data from approximately 5,100 reporting hospitals per year.

The second data source includes the Medicare Cost Reports for a large subsample of PPS-eligible hospitals (over 4,000). Besides having financial data on profits and capital assets not reported by the AHA, this file also has key HCFA payment information such as the hospital standardized amounts, indirect medical education status, and the local PPS wage index. They are also useful in defining urban and rural status for Medicare payment purposes.

As part of a larger evaluation of PPS undertaken by Abt Associates and Health Economics Research, Inc., the AHA and Medicare Cost Report data were merged, together with county-level data from the Area Resource File. In the merged data file, observations are organized by hospital and payment system. Thus, each variable has observations for each hospital in each payment system. There are four payment systems: "TEFRA," which is the fiscal year before PPS, and the first three years of PPS (PPS1-PPS3). Because of the wide range of hospital service and financial variables, and area characteristics, the merged file was used for the multivariate estimation reported in Section 5.

3.0 DESCRIPTIVE TRENDS BY TYPE OF SERVICE

This section provides summary data on descriptive trends in hospital service adoption and bed accommodations. The first subsection reviews the growth in alternative bed types. This is followed by three other subsections describing the diffusion of complexity-expanding, support, and outpatient services.

3.1 Bed Accommodations

Table 1 reflects the rather remarkable diversification of U.S. short-term general hospitals that has taken place in a few years under prospective payment. Most noticeable is the rapid growth in subacute forms of care. The percent of "acute care" hospitals offering subacute SNF, psychiatric and other forms of traditional subacute care went from 14.8 to 18.7 percent. Even more dramatic is the growth in special forms of subacute care. Rehabilitation bed care could be found in 4.7 percent of hospitals in 1982. By 1986, the percentage had doubled to 9.4 percent, with nearly one-in-ten hospitals providing rehab bed care. Swing beds grew even faster, going from 1.1 percent to 8.5 percent of hospitals over 4 years.

Within acute services, hospitals have clearly diversified into psychiatric and alcohol/chemical dependency beds. The latter has been particularly popular, doubling in frequency in just 4 years. Nearly one-in-seven hospitals had beds designated to treat alcohol and chemical dependency patients by 1986.

Within intensive care units, the trends are mixed. General medical-surgical ICUs continued to diffuse through 1984, then fell slightly (to 74.3 percent) two years later. Cardiac ICUs also appear to have become less popular between 1984 and 1986. This may be because declining volumes have encouraged hospitals to merge their general med-surg and cardiac ICUs.

Other ICU types, however, continue to diffuse: neonatal units up from 8.0 to 10.4 percent of hospitals; pediatric units up from 3.4 to 4.6 percent; and burn care units up 0.1 percent.

All of these trends seem consistent with PPS incentives to (a) stratify acute bed units more sharply to provide more subacute care for med-surg patients, (b) shift care away from PPS-covered to excluded services (e.g., psychiatric care), and (c) diversify to other forms of care that are less intensive or provide alternative sources of revenue (e.g., rehab).

3.2 Complexity-Expanding Services

Of particular interest is the effect of prospective payment on the diffusion of complexity-expanding inpatient services. These usually reflect the latest, most beneficial, and most costly medical technologies. Given the high cost of most of these services, the direct PPS response should be to slow their diffusion, which would be reinforced by the extraordinary volume declines occurring since 1983.

Table 2 shows the diffusion of 12 of these services over the 1981-86 period. Diffusion of certain complexity-expanding technologies has been particularly rapid over the first six years of the decade. In 1982, CT scanners were in 30 percent of short-term hospitals; four years years the percentage had doubled to nearly 60 percent. Nuclear magnetic resonance (NMR) first started being reported in 1983. In just three years its diffusion level had also doubled from 3 to 6 percent. Diagnostic ultrasound is also a fast diffusing new technology, even though over 70 percent of hospitals reported having the service in 1981. By 1986, 86 percent had ultrasound capabilities, implying that it had diffused to a significant number of small rural hospitals.

Open heart surgery and its complementary service, cardiac catheterization, have also continued to diffuse throughout the pre- and post-PPS period. In 1983, 11.1 percent of hospitals offerred the service, or one-in-nine. By 1986, 13.1 percent were performing open heart surgery, or one-in-7.5 hospitals. This diffusion rate does not compare with that of CT scanners and NMR, but is noteworthy nevertheless considering how expensive (and risky) it is for a hospital to enter this field.

Five core radiological technologies have diffused very slowly if at all during the 1980s. This may partly be explained by the substitution of noninvasive CT scan and NMR technologies. It may also be the result of shifts in the site to ambulatory clinics not part of the hospital.

Table 3 shows variations in the level and rate of diffusion of the 12 complexity-expanding services by hospital size, type, and location. To simplify the presentation, we aggregate across the services and present trends in the percentage of the 12 services provided. Thus, in 1981, the typical U.S. short-term general hospital had 27 percent, or a little over 3.2 of these services. By 1986, the percentage had risen to 30 percent, or 3.6 services, an 11 percent increase in the adoption share. This is not a very rapid increase--particularly compared to some other service groups shown later, but the trend is deceiving in that some complex services did not diffuse at all between 1982-86 or were actually negative on a net basis (e.g., radiation therapy).

It has been known for a long time that diffusion levels are highly correlated with hospital bedsize (Berry, 1973; Russell, 1978; Cromwell and Kanak, 1982). This is clearly illustrated in Table 3. The under-100 bed urban hospital averaged 12.3 percent of the 12 services in 1981, or 1.5, versus nearly 86 percent, or 10.3 services, for the over 504-bed hospital. Size also explains most of the regional, teaching, and ownership differences observed in Table 3 (see multivariate results below).

The rate of diffusion, on the other hand, is usually inversely related to the level of adoption. That is, hospitals already having a large number of complex services are, by definition, going to have a smaller percentage increase in their overall adoption level if they add an additional service.

This, too, is evident in Table 3 from a comparison of changes in the percent of services provided shown in the last column. The average under-100 bed urban hospital had nearly a 36 percent growth in its percent of complex services in 6 years compared to 8.8 percent growth in the 405-504-bed group (and negative growth among the very largest urban hospitals). In absolute numbers, however, the 405-504-bed group adopted .72 new complex services on average versus just .52 for the under-100 bed group.

At least in percentage terms, the small, under-50, bed rural hospital exhibited the highest adoption rate between 1981 and 1986: 52.5 percent. This amounted to the adoption of only about .3 complexity-expanding services, however. The 50-99-bed hospital had the highest absolute change among rural hospitals, adopting .61 new services. Yet, given the financial problems of the small rural hospitals in recent years ProPAC, 1988, pp.68-72; Hendricks, et al., 1988, ch.6), brought on by very large volume declines, it is noteworthy that they continue to adopt any of these expensive complex services.

Because of their smaller average bedsize, rural hospitals have only about one-third of the complexity-expanding services offerred in urban hospitals. Moreover, even though their rate of adoption is higher in percentage terms than urban hospitals, the latter did adopt slightly more new complex services over the six year period (i.e., .42 vs. .31 in rural hospitals).

3.3 Medical Support Services

Complex services are the primary way new, life-saving technologies are introduced into the medical sector. Certain support services also serve an important role in rehabilitating patients after traumatic surgery and assuring that other hospital services are of high quality and effectiveness. Seven of these services are shown in Table 4. The first two, blood bank and histopathology lab, have hardly diffused at all between 1982 and 1986. The rest, by contrast, show continued diffusion, even though two, physical and respiratory therapy, were already at high levels. The rapid growth in all the therapies coincides with the hospital's need to rehabilitate patients quicker before discharge, as well as to diversify into new revenue-generating services.

3.4 Outpatient Services

The third set of services to be analyzed reflects the institution's outreach into the community. PPS incentives to diversify and follow patients after discharge are strong to make sure they are adequately cared for and to generate revenues to offset inpatient volume declines.

Table 5 presents 4-year diffusion trends for 10 outpatient services. The changes are impressive. Slightly over 38 percent of hospitals had an organized outpatient department prior to PPS; by 1986, the percentage had jumped to 63 percent. Outpatient alcohol/chemical dependency services went from 10.8 to 16.5 percent; occupational therapy from 32.8 to 43.2 percent.

Of course, the most remarkable of all is an organized home health program provided by the hospital. In 1982, only 12.2 percent of hospitals offerred this service to discharged patients. Just four years later the percentage had tripled to 35.4 percent. And this is just home health services provided directly by the hospital and does not include the many non-hospital-based agencies offering such services.

Table 6 summarizes the overall adoption shares for eight selected outpatient services by hospital size, type, and location. Overall, in 1982, the average hospital provided 35.4 percent of the eight services, or 2.8 services. Four years later, the percentage was 44.3, an increase to 3.6 services.

As with complexity-expanding services, diffusion levels correlate strongly with bedsize, although the percentage difference between small and large hospitals is not quite as great. And while the rate of diffusion is still generally inversely correlated with initial diffusion levels, the trends are much looser. For example, the under-50 bed rural hospital raised its adoption level nearly 9 points between 1982 and 1986 compared to a 12 point increase for over-169 bed rural hospitals. The former change was greater in percentage terms, but less in absolute terms, i.e., .7 vs 1.0 services. Even the very large urban hospitals added more than half an outpatient service (out of eight).

4.0 DIFFUSION OF SERVICES WITHIN MSAs

The preceding section presented trends in the level and rate of adoption of various kinds of hospital services but they do not give a very good picture of patient access over time. Specifically, aggregate trends do not tell us whether a second hospital in the same city began performing open heart surgery or whether this service was being offerred for the first time in another city.

Similar kinds of diffusion trends are presented in this section, but this time they are aggregated by MSA (all rural areas are excluded due to a lack of a well-defined market). For selected bed accommodations and service groups, we report the number of MSAs with 1, 2, 3, or more hospital-based units. While this is by no means definitive regarding patient access, even in cities, it does shed some light on the geographic nature of the diffusion. We may also be able to say something about the extent of hospital service rivalry under PPS.

4.1 Bed Accommodations

Table 7 shows the distribution of 326-30 MSAs by the number of bed accommodations of a selected type in each of three years. The bed types reflect the availability of various kinds of intensive care as well as two community-oriented services; namely, rehab and alcohol/chemical dependency. The distributions show, for example, that general med/surg ICU beds were available in all but 6 MSAs in 1982 and that 46 MSAs had 11 or more ICU units in 1982. In sharp contrast, 233 MSAs were without distinct burn care units in 1982 while 2 MSAs had at least 5.

If units are diffusing to heretofore unserved cities, the number of MSAs without a particular accommodation will fall over time and the number with 1 unit will rise. Furthermore, the number of MSAs with a given number of units may rise or fall over time depending on whether hospitals in an MSA added or subtracted services.

Medical/Surgical ICUs provide a good reference service in that their distribution is almost unchanged over the 1982-86 period. Thus, on net, about as many MSAs had, say, 3 such ICUs in 1986 as in 1982 (actually there were 3 less MSAs). And while there were 5 fewer MSAs with a single unit, in 1986 versus 1982, it was not that these areas went unserved. MSAs with 2 units actually increased slightly, suggesting that a couple of MSAs adopted a second unit. (There is also a slight increase in the number of MSAs over the period from 326 to 330, which could explain the increase in the number of unserved MSAs between 1984 and 1986.)

The two accommodations showing the greatest geographic diffusion are neonatal ICUs and rehabilitation beds. In 1982, 146 MSAs were without a neonatal unit compared to 111 four years later. Most of the unserved MSAs in 1982 apparently had a single unit by 1986, as evidenced by the sizable increase in the number of MSAs with a single unit (127 versus 105 in 1982). The growth in the number of MSAs with three or more such units is striking as well: 55 in 1986 vs. 35 in 1982.

Diffusion of rehab units within and across MSAs is even more pronounced. In 1982, 209 MSAs were without a rehab unit compared to 145 four years later. (It should be kept in mind that our sample excludes rehad hospitals, *per se*.) Again, about one-half of this change is explained by a heretofore unserved city getting a unit, but the diffusion among areas already having several units is again striking. Forty-six MSAs had 3 or more units in 1986 vs. 18 in 1982. In spite of several hospitals already offering rehab, competitors apparently see the need, or the financial opportunity, to open new units. Whether this kind of diffusion substantially improves access is a fair question.

Cardiac ICU units present an interesting counter-example of a service that may be becoming more regionalized over time. First, although the number of unserved MSAs grew only slightly, the number of MSAs with just one cardiac-specific ICU increased by 20 in just 4 years. Conversely, the number of MSAs with 3 or more units fell by 19 from 117 to 98. This suggests that the need to have specially-designated units in cities where many already exist is being re-evaluated in an era of declining volumes and greater cost consciousness.

4.2 Complexity-Expanding Services

Table 8 presents an identical table for eight complexity-expanding services. We have already seen that open heart surgery has diffused gradually from about 10 to 13 percent of all hospitals. Given that practically all such operations are done in urban hospitals, what does this imply for access in the city? As of 1982, 134 MSAs did not have an open heart surgery suite. By 1986, the number without a suite had fallen to 114, implying that 20 new cities now had the capability. However, only 4 more MSAs on net reported having a single suite, implying further diffusion of suites into cities already having the capability. For example, in 1982, there were 30 MSAs with at least 5 open heart surgery suites. By 1986, just four years later, there were 42, an increase of 40 percent.

The drop in the number of MSAs without cardiac catheterization was even greater as 31 picked up at least one such service. Again, the net increase in MSAs with a single unit was minimal (i.e., one) as the technology diffused into cities already having one or more units. For example, the number of MSAs with 6 or more units increased from 34 to 46, or 35 percent.

We have already noted in Table 2 that CT scanners were the most rapidly diffusing complex technology over the 1982-86 period. But even by 1982, the vast majority of cities already had at least one scanner (only 14 did not). By 1986, virtually all had a least one scanner (only 1 in 330 MSAs did not). Again, the diffusion was so strong that the number of MSAs having zero, one, or two scanners actually fell during the period. Forty new MSAs had 3-5 scanners and 41 new MSAs had 6 or more. A similar diffusion pattern is evidenced for diagnostic ultrasound, although this technology seems further along in its overall diffusion.

Nuclear magnetic resonance is an interesting case as we pick up its diffusion at its initial stages, much like CT scanners in the late 1970s and early 1980s. As expensive as CT scanners are, NMR is even more so, making its diffusion an even more costly one. This technology is so highly regarded that ProPAC requested a special add-on to the DRG rate whenever the procedure is done so as not to discourage its diffusion.* Whether such an add-on was needed is debatable after looking at the diffusion of this very expensive technology. In 1982, 319 MSAs out of 326 did not have the service, or 98 percent. Four years later, only 201 of 330 MSAs (or 60 percent) were without the service. Actually, even this is probably a significant understatement of its availability given the diffusion of the service to non-hospital settings. It should be remembered that our figures apply only to hospitals. Of the 118 MSAs that adopted at least one new NMR unit, 59 can be accounted for as having one unit by 1986. The number of MSAs having 2 such units went from 2 to 28. Finally, as of 1982, no MSA had more than 2 hospital-based units compared to 37 MSAs with 3 or more by 1986. These trends suggest that NMR is diffusing rapidly in cities throughout the country, both in MSAs without units as well as among larger cities already served by a few units.

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*ProPAC recommended a $124 add-on for each scan, updated annually, for at least three years (ProPAC, 1986, p. 53). HCFA rejected the add-on and it was never implemented.

Organ transplant the only complex service showing no real diffusion. In fact, 4 MSAs on net appear to have loss this capability between 1982 and 1986. If anything it appears that this very complicated and costly service is becoming more regionalized in spite technical changes that make this capability more feasible.

4.3 Outpatient Services

Table 9 provides similar geograhic dispersion data for eight outpatient services. As of 1982, there were 33 MSAs where patients had no organized outpatient department (OPD) to go to, although all but 2 MSAs had at least one emergency department. Four years later, only 9 MSAs were still left without a hospital outpatient department. In fact, the diffusion of OPDs appears throughout the urban markets regardless of how many competitors originally existed. For example, 78 MSAs had at least 5 OPDs in 1982 vs. 118 four years later. Hospitals are clearly seeing it in their financial interests to open their own OPD to follow their own patients outside the hospital and possibly to avoid leakages of patients to other hospitals already having units.

Even by 1982, practically all MSAs had access to at least one hospital-based ambulatory surgical service. Interesting, however, is the large increase in the number of MSAs having 11 or more such services, which suggests almost 100 percent diffusion of ambulatory surgery in even the largest markets.

Both outpatient alcohol/chemical dependency and psychiatric services continued to show strong diffusion to unserved MSAs over the early PPS period, with 52 and 30 newly-served MSAs, respectively.

And finally, the outpatient department notwithstanding, home care remains the clear leader in its diffusion to new urban markets. As late as 1982, 173 MSAs were without a hospital-based home care program, or over half of our cities. By 1986, only 57 (or 17 percent) were still without at least one hospital-based program. One hundred and sixteen new MSAs adopted at least one home care program, and many MSAs that already had several continued to see more spring up as hospitals scrambled to follow their patients and generate additional revenues. Whereas 14 MSAs had 5 or more hospital-based home care programs prior to PPS, by 1986, 54 had 5 or more.

5.0 REGRESSION TESTS OF PPS IMPACTS ON SERVICE DIFFUSION

5.1 Variable Definitions, Specification, and Econometric Issues

The diffusion curves of many hospital technologies are long relative to the time hospitals have been subject to Medicare's Prospective Payment System. Lags in data gathering further reduce available post-PPS observations. For these reasons, time series analysis currently provides only limited evidence of PPS impacts on technology or service diffusion.

Exploiting cross-sectional variation in PPS impacts on hospitals is a more promising way of measuring short-run PPS effects on diffusion. We use two variables to capture cross-sectional variation in PPS impacts in our multivariate work. The first measures the predicted short-run financial gain (or loss) of a hospital from PPS. The GAIN variable is the product of Medicare dependence (defined as the share of costs due to Medicare patients in the TEFRA year) and the percentage difference in a hospital's first-year PPS payments per case and its TEFRA costs per case*. The hypothesis is that the more a hospital gains financially from PPS, the more likely it is to add new services or technologies. Conversely, the greater financial pressure PPS puts on a hospital, the less likely it is to add services, or the more likely likely it is to eliminate them, in an attempt to constrain its costs. The second cross-sectional variable is Medicare dependence (defined as above). Hospitals that are more dependent on Medicare business should exhibit more strongly any PPS effects.

The limitations of these two variables as measures of PPS effects should be noted. The GAIN variable measures only the direct financial impact of PPS. Its cross-sectional variation does not capture the change in incentives faced by all hospitals as the result of the transition from cost-based to prospective reimbursement. A hospital with the same financial surplus might behave differently facing cost versus prospective reimbursement. Moreover, it measures the PPS financial impact assuming no behavioral response. Hospitals' actual margins under PPS may have been quite different as they undertook cost-cutting measures such as reducing length of stay.

The effects of Medicare dependence are relative to reimbursement methods used for non-Medicare patients. Effects will differ depending on whether non-Medicare patients are reimbursed by prospective, cost, charge-based, or other methods. The Medicare dependence variable takes no account of variation in these methods from hospital to hospital, area to area, or over time. It does not measure the effects of Medicare's PPS relative to previous cost-based reimbursement unless non-Medicare patients are reimbursed exclusively on a cost basis in the post-PPS era.

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*Other studies of PPS impacts (e.g., Feder, Hadley, and Zuckerman, 1987; Lave et al., 1988) have used a similar variable to measure PPS impacts.

In addition, in the dependence variable, effects of PPS may be confounded with casemix differences of Medicare and non-Medicare patients. We are able to control for Medicare casemix in our regressions through a DRG-based casemix index. Unfortunately, we have no information on non-Medicare casemix. Since Medicare patients, on average, are more difficult to treat and require more services than non-Medicare patients, a positive coefficient on Medicare dependence may be picking up the more difficult casemix of Medicare patients, rather than the effects of prospective payment.

To test PPS effects, we include the GAIN and Medicare dependence variables in regressions explaining hospital adoption of services. Several regressions explain the adoption of two individual services, CT-scanner and Nuclear Magnetic Resonance Imager (NMR). Multi-service counts of complexity-enhancing services and outpatient services are the dependent variables in other regressions.

To isolate PPS effects, other factors influencing service adoption must be held constant. Many of these factors are of interest in their own right. Without a formal model at this stage of our research, we specify hospitals' level and rate of adoption of services as a function of the benefits and costs to the hospital of adding services (Russell, 1984). The benefits of service adoption are higher when there is a greater demand for them. For many services, demand is primarily a derived demand from the number and type of cases treated (Romeo, Wagner, and Lee, 1984). Hospital bedsize proxies for volume of derived demand and also for cost per case as larger hospitals can more efficiently utilize indivisible equipment and services. The change in the number of discharges measures changes in derived demand. A positive effect of Medicare casemix on service adoption is expected because more complex cases increase the demand for services. Teaching status and bedsize also pick up derived demand from difficult cases or teaching functions. County per capita income is expected to have a positive effect on service adoption as higher income raises demand. Population density will have a negative coefficient if travel time to hospitals is greater in less densely populated areas, increasing demand for services at hospitals existing in those areas. A larger number of physicians per capita may raise demand for services or proxy for other, unmeasured factors that increase the demand for medical services in an area.

The costs of service adoption are more difficult to measure than the benefits. Prospective payment creates an opportunity cost of adding services (Russell, 1984). Therefore, it is expected to slow service diffusion relative to cost-based reimbursement. Adding services invariably raises labor costs.

For example, the one-year operating costs associated with CT-scanners or NMRs are roughly equal to the total capital expenditure (Hillman, 1986). If higher labor costs discourage service adoption, we expect a negative coefficient on the PPS hospital wage index we include in the regressions. Hospitals belonging to multihospital systems may have a lower cost of capital which encourages service adoption. If so, this variable will have a positive coefficent. Similarly, hospitals with greater financial surpluses may face a lower cost of capital if retained earnings are cheaper than external borrowing. Indeed, nonprofit hospitals with surpluses face the necessity of reinvesting them. For both reasons, a positive coefficient on a hospital's total margin is expected.

Several other independent variables are included in the regressions. Competitive considerations have been shown to affect hospital service adoption (Luft et al., 1986). To measure competition, we include two variables. A Herfindahl index of beds measures the general potential for competition in a hospital's market area. The percent of neighboring hospitals with the service in question measures specific product line competition.* For urban hospitals, the Herfindahl index is defined for SMSAs; for rural hospitals, it is defined for a hospital's county and contiguous counties, whether urban or rural.** Neighboring hospitals are those within the sample hospital's county. For-profit and government ownership measure differences in the hospital's objective function. It is often argued (e.g., Shortell et al., 1987) that proprietary hospitals are less likely to offer a full range of services than other hospitals while government hospitals are more likely to do so. The percent of (other) services offerred measures a hospital strategy of being a full-service, technically sophisticated hospital, making it more likely to adopt the service(s) in question. It also captures any unmeasured factors making the sample hospital more likely to adopt services. We plan to include variables measuring the presence and stringency of state CON programs and regulation of hospital reimbursement. These variables should clarify the Medicare dependence variable by helping control for reimbursement methods for non-Medicare patients. Unfortunately, they were not available to us at the time this paper was written.

In the multivariate work, we used the Abt/HER PPS evaluation file described in Section 2. It provides data on the relevant hospital and area variables discussed above. Hospitals are classified based on the Medicare payment system they were subject to rather than calender time. For this study, we had data for Medicare-eligible hospitals running from "TEFRA," the year prior to a hospital's going on PPS, to the third year of PPS (called PPS 3).

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*For the multiservice index regressions, this variable is defined as the average number of services of a specified type among neighboring hospitals.

**We are grateful to our colleague Ann Hendericks for creating the Herfindahl index.

Several difficult statistical issues are present in estimating the relationship between service adoption and its determinants with our data. The data is both right and left censored. That is, the timing of adoption of hospitals that adopted before the TEFRA year is unknown ("left censoring") as is the adoption time, if any, of hospitals that had not adopted by PPS 3 ("right censoring"). In addition, our theoretical specification is what is known in the econometrics literature as a "switching regimes" model. This is because the coefficients of several of our variables may change over time. The GAIN variable is expected to be zero for hospitals which adopted technologies before PPS because it was not relevant to decisions then.* Coincident with PPS, it is expected to be non-zero. Similarly, the coefficient on the Medicare dependence variable might change sign from positive to negative if cost-based reimbursement preceeding PPS encouraged service adoption while PPS discourages it. Econometric techniques to appropriately account for these issues separately exist (Lee and Waldman, 1985; Maddala, 1983). However, accounting for them jointly raises complex problems that we are currently evaluating.

For this paper, we have adopted the following (imperfect) estimation strategy. For each of our dependent variables--CT-scan adoption, NMR adoption, count of complexity-enhancing services, and count of outpatient services--two equations were estimated. The first explains the baseline, Pre-PPS level of service adoption in the TEFRA year. For the CT-scan and NMR regressions, the dependent variable is 0=the hospital did not have the technology in the TEFRA year, 1=the hospital had the technology in the TEFRA year, according to the AHA annual survey. For the service indexes, the dependent variable is the number of services each hospital reported in the relevant category in the TEFRA year. Definitions of "complexity-enhancing" and "outpatient" services are similar to those used in the descriptive work above.** Several independent variables relevant only to the post-PPS period are excluded from these regressions. Both NMR regressions are restricted to urban hospitals because virtually no rural hospitals had NMRs in our sample period. The sample for the other three regressions is all hospitals with complete (i.e., nonmissing) data.***

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*The long-lived nature of capital and anticipation may mean that expected PPS effects were relevant before PPS was actually implemented, but it is unlikely that these anticipation effects occurred for more than a short period before PPS implementation.

**Blood bank and histopathology were added to the complexity-enhancing services, while organ transplant was excluded. In addition, day hospital and geriatric services were added to the outpatient services, while psychiatric emergency services and occupational therapy were excluded.

***Missing data due to the lack of the 1987 AHA Annual Survey tape at the time our data file was created limits the sample size.

The second equation explains adoption behavior post-PPS, between the TEFRA and PPS 3 years. For the CT-scan and NMR regressions, the sample is restricted to only those hospitals that did not have the technology in the TEFRA year. The dependent variable is 0=still did not have the technology in PPS 3, 1=had the technology in PPS 3. For the indexes, the sample is all hospitals and the dependent variable is the change in the number of services offerred between TEFRA and PPS 3, which may be positive or negative. Therefore, these latter two equations explain disadoption behavior, as well as adoption behavior. Since the number of services which a hospital could potentially adopt between TEFRA and PPS 3 is limited by the percentage of services it already offerred in TEFRA, the percentage of services in TEFRA and the percentage squared are entered in the index regressions. To minimize potential endogeneity problems, TEFRA year values of independent variables were generally used.

Joint interpretation of the two equations for each dependent variable provides a meaningful picture of hospital service adoption and PPS impacts. For this paper, the reported results are based on ordinary least squares estimation of the equations. However, because the dependent variables in the CT-scan and NMR equations are binary variables, they would be more appropriately estimated by probit. We are currently doing so.

5.2 Results

We will first discuss results for the two individual services, CT-scan and NMR, then take up the results for the counts of complexity-enhancing and outpatient services. CT-scan provides a good chance to estimate the impact of PPS on "big-ticket" technology adoption because it was diffusing rapidly during the period when PPS was introduced (see Table 2).

The two CT-scan regressions are reported in Table 10. The PPS GAIN variable is excluded from the first regression as irrelevant to pre-PPS adoption decisions. The coefficient of the GAIN variable is not statistically different from zero in the second regression. That is, the predicted financial gain from PPS has no statistically significant effect on the likelihood of CT-scan adoption by PPS 3 among hospitals that had not adopted by the TEFRA year.

Medicare dependence is included in both regressions since it is potentially relevant to pre- or post-PPS decisions, although possibly with different signs. Pre-PPS, Medicare dependence has a statistically significant positive effect on the likelihood of adoption of CT-scan. A hospital with 100 percent Medicare volume is estimated to have a 12 percent greater likelihood of a having a CT-scan in the TEFRA year than a hospital with no Medicare volume. This effect is consistent either with Medicare cost-based reimbursement promoting technology adoption, or with the more severe casemix of Medicare patients increasing the likelihood of adoption. Post-PPS, Medicare dependence continues to have a positive effect of similar magnitude on adoption, but the coefficient is no longer significantly different from zero.* Taken together, the pre- and post-PPS coefficients do not provide any strong evidence of a change in the effect of Medicare dependence on technology adoption post-PPS.

The negative Herfindahl coefficients indicate that more potential competition among hospitals increases the likelihood of adoption, but the effects are small (less than one percent), and not significantly different from zero. Conversely, the negative coefficient on percent of neighbors with CT-scanners indicates that more specific competition in providing CT-scans reduced the likelihood of adoption post-PPS. Again, the effect is small and statistically insignificant.

A hospital's total margin in TEFRA had a statistically significant effect on the likelihood of adoption between TEFRA and PPS 3. An increase in the margin from 0 to 10 percent is estimated to increase the likelihood of adoption by about 2 percent. Medicare casemix has a strong impact on likelihood of adoption both pre- and post-PPS. A change from an index of .5 to 1.5 (roughly the range of the index across hospitals) is estimated to increase the probability of adoption in both periods by about 45 percent. The percent of complexity-enhancing services offerred in TEFRA also has a strong effect on the probability of adoption by PPS 3.** For example, a hospital that offerred 80 percent of services in TEFRA had a 32 percent greater chance of adopting by PPS 3 than a hospital that offerred 30 percent of the services in TEFRA.

Among other hospital-specific variables, bedsize has a very strong effect on the likelihood of adopting. Pre-PPS, the effect is especially strong above 100 beds, but levels off above 300 beds. Post-PPS, the bedsize effect is relatively stronger among smaller hospitals as diffusion activity shifted from the larger hospitals to them. Apparently, virtually all hospitals of more than 400 beds had adopted by TEFRA. Controlling for bedsize, teaching status is insignificantly related to adoption, except for a negative coefficient on minor teaching post-PPS. Ceteris paribus, government or for-profit control, percent change in the number of discharges post-PPS, and membership in a multihospital system are statistically insignificantly related to adoption pre- or post-PPS.

Among area characteristics, per capita income has the expected positive effect, although it is significantly different from zero only pre-PPS. Population density has a significant negative coefficient, perhaps for the reasons hypothesized in the preceeding section. Holding population density constant, urbanicity has no statistically significant effect. Physicians per capita is also insignificant. Hospital wages has an unexpected positive, significant coefficient in the pre-PPS regression. Areas with higher costs (wages) were more likely to adopt pre-PPS. This variable is highly correlated with urbanicity and population density and may be capturing some of the effects of those variables.

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*The Herfindahl index varies between 0 and 1 with 1 being monopoly and zero the limit of no concentration. Thus, a negative coefficient means that less concentration is associated with a greater likelihood of adoption.

**Dropping this variable from the equation did not have major effects on other coefficients.

Table 11 presents analogous results for NMR. The pre-PPS regression is much less successful in explaining the adoption of NMR by the TEFRA year than the pre-PPS CT-scan regression is in explaining adoption of CT-scan. The R-squares are 50 percent for CT scan and 2.6 percent for NMR. Only two coefficients are significant at the 5 percent level in the NMR regression.* Major teaching hospitals were 8.4 percent more likely to have NMR in the TEFRA year than nonteaching hospitals. An increase in the number of physicians per capita from 100 to 500 per 100,000 population is associated with about a 7 percent increase in a hospital's likelihood of having NMR in TEFRA. Interestingly, both teaching status and physicians per capita are insignificant in the CT-scan equation, while bedsize and casemix, which are strong predictors of pre-PPS adoption in the CT-scan equation, are insignificant in the NMR equation. Over this period, NMR was apparently an experimental technology strongly associated with major teaching hospitals and physician demand, while CT-scan had become more routinely associated with larger hospitals and those treating a more difficult mix of cases.

Medicare dependence has a positive sign in the pre-PPS NMR equation, which changes to negative in the post-PPS regression, but neither is significantly different from zero. PPS GAIN is also not significantly different from zero in the post-PPS equation. Percent of complexity-enhancing services offerred in the TEFRA year is by far the most important variable in the post-PPS regression. An increase from 30 to 80 percent of services offered raises the likelihood of having NMR in PPS 3 by about 14 percent. The addition of this variable may be why teaching status is insignificant in the post-PPS regression.

We now turn to the regressions explaining pre- and post-PPS adoption or disadoption of two categories of hospital services. Table 12 presents results for counts of complexity-enhancing services. The most important variables by far in the pre-PPS equation are casemix and bedsize. A one-unit increase in the Medicare casemix index is associated with about five more complexity-enhancing services (out of 13 total). Fifty to 99 bed hospitals have about one more service than under 50 bed hospitals, while over 400 bed hospitals have more than seven more services. Holding bedsize constant, major teaching hospitals have one additional complexity-enhancing service. Proprietary hospitals have a statistically significant .17 fewer services. Members of multihospital systems have a nearly statistically significant .10 more services. Competition has little effect on the number of complexity-enhancing services.

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*We hope to improve the precision of these estimates through probit techniques. Probit should be especially fruitful here because so few hospitals had adopted by TEFRA (about 3 percent).

Complete Medicare dependence is associated with about .4 more services pre-PPS than no Medicare dependence, and with the adoption of about .5 more services post-PPS. Neither coefficient is quite statistically significant. Surprisingly, the PPS GAIN coefficient is negative and statistically significant post-PPS. The effect is fairly small, however. Ceteris paribus, no predicted financial gain from PPS is associated with adopting about .2 more services post-PPS than a 5 percent gain (roughly the 90th percentile of GAIN).

The reasons for a negative, significant GAIN coefficient are unclear.* Perhaps hospitals that were under greater financial pressure from PPS added more services in an attempt to attract business and improve their financial position. Hospitals predicted to gain from PPS were short-stay, low-cost institutions. It may be that for unclear market specialization or other strategic competitive reasons that these hospitals tended to adopt fewer services post-PPS.

Among other variables in the post-PPS equation, casemix and bedsize continue to be important determinants of adoption, but are not as dominant as in the pre-PPS equation. As expected, the percent of services offered in TEFRA has a strong negative effect on the number of services adopted post-PPS, while the square of this variable is positive. Proprietary hospitals continue to adopt fewer services post-PPS, while the teaching coefficients become statistically insignificant. Hospitals whose discharges fell by less than -30 percent adopted .23 to .36 more services than hospitals whose discharges dropped by more than 30 percent. Population density continues to be negatively associated with adoption post-PPS, but hospital wages, which had a surprising, strong positive association with number of services pre-PPS, becomes insignificant post-PPS.

In the pre-PPS outpatient services regression (Table 13), casemix and bedsize are important variables, but they are not as dominant as in the complexity-enhancing services equation. For instance, greater than 400 bed hospitals have more than seven more complexity-enhancing services than under 50 bed hospitals, but only about 1.6 more outpatient services.** Proprietary hospitals have about .5 fewer outpatient services than voluntary hospitals as compared to .17 fewer complexity-enhancing services. Government hospitals have .2 fewer outpatient services, which is statistically significant, while their number of complexity-enhancing services is not statistically different from voluntary hospitals. Minor teaching hospitals have more outpatient services than complexity-enhancing services relative to nonteaching hospitals, while major teaching hospitals have relatively more complexity-enhancing services. Membership in a multihospital system is again associated with .1 more services.

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*The GAIN variable is not highly correlated with any of the other independent variables, so it is unlikely that dropping other variables from the equation would change its sign.

**There are 13 total complexity-enhancing services and 10 total outpatient services.

The competition variables are more important in determining the number of outpatient services than complexity-enhancing ones. One more outpatient service, on average, among neighboring hospitals is associated with about .1 more outpatient services in the sample hospital, which is statistically significant. This is consistent either with a competition effect or with unmeasured greater demand for outpatient services in certain areas. The Herfindahl index coefficient, on the other hand, indicates that more outpatient services are associated with greater concentration. The coefficient is nearly significant at the 10 percent level. Specific competition in outpatient services seems to promote adoption, while more general potential competition may retard it.

Medicare dependence is significantly negatively associated with the number of outpatient services pre-PPS, in contrast to a positive, insignificant effect on the number of complexity-enhancing services. Complete Medicare dependence is associated with about .8 fewer outpatient services than no Medicare dependence. Post-PPS, Medicare dependence has no statistically significant effect on outpatient service adoption. PPS GAIN again retards post-PPS service adoption, with a coefficient of similar magnitude to the complexity-enhancing services regression.

Among other variables in the post-PPS regression, percent of outpatient services offered in TEFRA has the expected strong, negative effect. Bedsize continues to have a positive effect on adoption, while government and for profit hospitals continued to add fewer services. Per capita income is positively associated with the number of outpatient services added.

6.0 CONCLUSIONS

Without question, U.S. short-term general hospitals have undertaken major changes in the way they diagnose and treat patients since the inception of PPS. Some of these changes have been dramatically confirmed in this paper. Hospitals have pushed rapidly into alternative uses of beds and services--particularly on a subacute or ambulatory basis. Rehab, swing, and alcohol/chemical dependency beds have appeared in hospitals and cities where they were absent. The percent of hospitals with home care programs has tripled in just four years and the percent with an organized outpatient department has doubled. This is true even among average sized rural hospitals even though many have had financial troubles due to declining inpatient volumes.

All of these changes reflect the industry's rapid response to the very clear incentives of PPS (and other third party initiatives) to diversify into non-acute forms of care. These incentives either follow directly from the need to discharge patients sooner and treat on an ambulatory basis or indirectly from a desire to generate new revenue sources from lost inpatient volumes.

Seemingly unaffected has been the diffusion of costly, complexity-expanding services such as open heart surgery, CT scanners, and nuclear magnetic resonance. The early concerns that fixed payment would discourage adoption of these life-saving technologies are not supported by either the descriptive or the multivariate results reported above. The usual hospital and area characteristics like bedsize, teaching status, profitability, and casemix severity, dominate any statistical explanations of diffusion levels. PPS-related variables play little role; indeed, expected losers under PPS were found to be more likely to adopt new complex services, holding bedsize, profits, volume changes, and other variables constant.

There are several possible explanations for a lack of a PPS-induced slowdown in the adoption of expensive services. First, PPS excluded capital costs, which continued to be paid on a passthrough basis.

Second, many hospitals enjoyed unexpected windfall profits under PPS due do DRG upcoding, improved productivity, and shifts in the site of diagnostic and therapeutic care.

Third, PPS heightened the interhospital competition for patients, which is manifested in part through the range of complex services offerred. Hospitals could no longer be indifferent to the adoption of a CT scanner, for example, by a competitor because of the implications it could have for admissions and inpatient revenues. This competitive effect is true even for the most complex and costly of services such as open heart surgery.

And fourth, it is also possible that the adoption decision for several of these new technologies was made prior to PPS and could not be revoked. In this case, the continued adoption of these and other as yet undeveloped technologies is still a question mark. That hospitals continued to adopt these critical services in the infancy of DRG fixed payment rates does not guarantee they will do so five or ten years from now. Nevertheless, the fact that PPS did not lead to an immediate halt in their diffusion is reassuring and possibly a bit encouraging for the future.

TABLE 1

TRENDS IN ACUTE, INTENSIVE CARE, AND SUBACUTE BEDS, 1982, 1984, AND 1986

	1982		1984		1986	
	Percent Hospitals with Bed Type	Average Number of Beds	Percent Hospitals with Bed Type	Average Number of Beds	Percent Hospitals with Bed Type	Average Number of Beds
BED ACCOMMODATION						
ACUTE						
Pediatric	49.7%	17.3	48.5%	16.8	46.4%	16.3
Psychiatric	19.9	31.4	20.7	32.2	22.1	33.0
Obstetric	69.2	15.5	69.8	15.6	68.3	16.0
Alcohol/Chemical Dependency	7.3	24.8	9.9	24.8	14.1	24.0
ICU						
Medical-Surgical ICU	72.6	9.6	76.6	9.8	74.3	10.5
Cardiac ICU	27.8	8.3	26.4	8.7	21.7	9.3
Neonatal ICU	8.0	14.3	9.6	14.6	10.4	14.9
Pediatric ICU	3.4	6.2	4.1	6.1	4.6	7.5
Burn Care	2.2	9.9	2.2	9.6	2.3	10.2
SUBACUTE CARE BEDS	14.8	59.2	15.0	57.5	18.7	55.1
OTHER BED TYPES						
Rehabilitation	4.7	26.7	6.6	26.0	9.4	25.7
Hospice	0.7	8.6	1.2	6.9	1.7	7.1
Alcohol/Chemical, subacute	.	.	2.0	22.1	2.4	21.7
Swing Beds	1.1	6.5	5.9	12.7	8.5	17.7

Definitions: **SUBACUTE** includes SNF, psychiatric, and other long-term care; mental retardation; sheltered care; self care; and other subacute care not included in OTHER BED TYPES in table.

Source: AHA Annual Survey tapes, 1982-86.

TABLE 2

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING COMPLEXITY-EXPANDING SERVICES, 1981-86

SERVICE	1981	1982	1983	1984	1985	1986
Open-Heart Surgery	10.2%	10.8%	11.1%	11.4%	12.1%	13.1%
Cardiac Catheterization	15.3	16.1	16.5	17.1	18.1	19.7
Hemodialysis	23.3	22.1	23.6	24.7	26.3	26.4
Diagnostic Radioisotope	63.0	62.9	66.3	67.4	68.1	63.8
Megavoltage Radiation Therapy	15.6	15.8	15.7	15.7	16.5	16.4
Radioactive Inplants	22.4	22.2	22.5	23.3	24.7	23.5
Therapeutic Radioisotope	23.4	23.3	23.0	23.6	24.2	23.3
X-Ray Radiation Therapy	19.9	19.3	17.1	17.1	17.7	17.1
Diagnostic Ultrasound	71.4	72.9	78.5	82.2	85.6	86.1
Nuclear Magnetic Resonance	.	.	3.1	3.4	5.0	6.6
C.T. Scanner	.	30.9	38.5	46.8	55.2	59.2
Organ Transplant	5.3	5.0	5.2	5.2	5.3	4.9

Source: AHA Annual Survey tapes, 1981-86.

TABLE 3

TRENDS IN COMPLEXITY-EXPANDING SERVICES BY HOSPITAL CHARACTERISTIC, 1981-1986

	PERCENT OF SERVICES PROVIDED*						
CHARACTERISTIC	1981	1982	1983	1984	1985	1986	Total Percent Change 1981-86
All Hospitals	27.0%	27.4%	26.8%	28.1%	29.9%	30.0%	11.1%
Region							
New England	32.8	32.0	31.0	31.9	33.9	33.7	2.7
MidAtlantic	36.0	37.1	36.4	37.4	39.1	39.0	8.3
South Atlantic	29.5	31.0	28.8	30.1	31.5	31.7	7.5
ENC	31.4	31.3	31.2	32.6	34.7	34.3	9.2
ESC	22.1	23.0	22.8	24.2	26.0	27.6	24.9
WNC	19.9	19.4	19.6	20.8	22.7	22.8	14.6
WSC	23.4	24.3	23.4	25.4	27.1	25.9	10.7
Mountain	21.1	20.6	20.1	22.6	23.9	25.3	19.9
Pacific	33.3	33.9	33.5	34.1	36.3	37.7	13.2
Teaching Status							
Non Teaching	20.4	20.7	20.7	22.2	23.8	24.2	18.6
Other Teaching	55.4	56.4	53.1	54.6	56.0	57.0	2.9
Major Teaching	78.7	78.4	71.4	72.5	74.7	73.4	-6.8
Rural	14.7	14.3	14.7	15.9	17.4	17.3	17.7
< 50 Beds	5.9	5.2	6.4	7.4	8.4	9.0	52.5
50-99 Beds	13.1	12.8	13.7	15.6	18.0	18.2	38.9
100-169 Beds	25.1	24.6	24.1	26.2	28.0	29.1	15.9
> 169 Beds	43.3	45.0	42.1	43.9	46.7	45.6	5.3
Urban	39.6	40.8	39.3	40.7	42.9	43.1	8.8
< 100 Beds	12.3	12.3	13.3	15.3	16.2	16.7	35.8
100-199 Beds	26.1	25.9	26.7	28.7	31.2	31.1	19.1
200-299 Beds	44.3	46.0	42.9	44.9	46.8	48.6	9.7
300-404 Beds	57.1	59.0	56.1	56.8	60.2	61.4	7.5
405-504 Beds	68.5	71.2	66.4	68.0	71.6	74.5	8.8
> 504 Beds	85.8	86.7	79.2	80.7	83.5	84.0	-2.1
Control							
Voluntary	32.7	33.3	32.1	33.3	35.3	35.6	8.9
Proprietary	23.0	21.8	22.5	24.7	26.3	26.8	16.5
State and Local	18.3	18.8	18.7	19.8	21.4	20.9	14.7

*Figures in table are unweighted percentages of 12 complexity-expanding services directly provided by hospitals. See Table 2 for list.

Source: AHA Annual Surveys, 1981-86.

TABLE 4

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING SUPPORT SERVICES, 1982-86*

SUPPORT SERVICE	1982	1984	1986
Blood Bank	70.9%	72.0%	71.9%
Histopathology	64.1	64.0	62.1
Physical Therapy	86.9	89.8	89.6
Occupational Therapy	32.8	37.2	43.2
Recreational Therapy	18.9	21.2	25.0
Respiratory Therapy	91.7	94.0	92.6
Speech Pathology	34.0	41.2	47.9

Source: AHA Annual Survey tapes, 1982-86.

TABLE 5

PERCENT OF PPS-ELIGIBLE HOSPITALS PROVIDING OUTPATIENT SERVICES, 1982-86

	1982	1984	1986
OUTPATIENT SERVICE			
Emergency Department	94.9%	96.3%	95.5%
Outpatient Department	38.3	46.3	63.0
Alcohol/Chemical Outpatient	10.8	12.8	16.5
Psychiatric Emergency Services	27.4	29.1	30.7
Psychiatric Outpatient Services	11.2	12.2	14.1
Occupational Therapy	32.8	37.2	43.2
Rehabilitation Service	29.4	33.2	35.5
Home Care Program	12.2	22.2	35.4
Ambulatory Surgical Service	86.3	91.2	93.8
Hospice	8.0	10.4	14.3

Source: AHA Annual Survey tapes, 1982-86.

TABLE 6

TRENDS IN OUTPATIENT SERVICES BY HOSPITAL CHARACTERISTIC, 1982-1986*

CHARACTERISTIC	PERCENT OF SERVICES PROVIDED		
	1982	1984	1986
All Hospitals	35.4%	39.3%	44.3%
Region			
New England	51.1%	53.4%	54.4%
MidAtlantic	48.1	50.6	54.2
South Atlantic	32.4	35.9	40.0
ENC	40.6	45.1	50.5
ESC	28.6	31.9	36.7
WNC	34.6	39.8	45.3
WSC	28.2	32.1	38.1
Mountain	34.5	38.7	45.3
Pacific	37.9	41.6	47.4
Teaching Status			
Non Teaching	31.6	35.6	40.9
Other Teaching	52.5	56.9	61.0
Major Teaching	59.1	61.1	64.8
Rural	29.0	32.5	38.0
< 50 Beds	24.4	27.4	33.0
50-99 Beds	28.3	32.0	38.4
100-169 Beds	34.8	39.4	45.6
> 169 Beds	43.1	48.6	55.0
Urban	41.9	46.3	50.8
< 100 Beds	26.2	29.9	34.8
100-199 Beds	35.1	40.4	45.7
200-299 Beds	46.0	49.7	54.9
300-404 Beds	52.0	57.3	61.9
405-504 Beds	55.7	61.4	64.9
> 504 Beds	63.1	65.8	70.8
Control			
Voluntary	40.1	44.3	49.4
Proprietary	27.9	32.8	37.0
State and Local	29.6	32.7	38.0

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*Figures in table are unweighted percentage of eight outpatient services: emergency, outpatient dept., alcohol/chemical dependency, psychiatric outpatient, rehabilitation, home care, ambulatory surgery, and hospice.

Source: AHA Annual Survey tapes, 1982-86.

TABLE 9

DISTRIBUTION OF MSAs BY THE NUMBER OF COMMUNITY OUTPATIENT SERVICES IN THE MSA, 1982-86

Number of Units In MSA	ORGANIZED OUTPATIENT DEPT.			EMERGENCY DEPARTMENT			AMBULATORY SURGICAL SERVICE			PSYCHIATRIC OUT-PATIENT SERVICES		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	33	26	9	2	1	1	2	1	2	141	130	111
1	83	56	57	26	24	23	22	21	19	89	95	108
2	61	72	54	68	65	63	68	63	62	44	47	48
3	45	43	56	44	38	46	44	41	49	12	15	14
4	26	31	36	40	46	47	46	42	41	14	13	12
5	15	27	22	35	36	30	30	36	31	7	8	10
6-10	33	36	50	62	57	58	63	63	63	10	10	18
11+	30	37	46	49	61	62	51	61	63	9	10	9

Number of Units In MSA	HOME CARE PROGRAM			HOSPICE			ALCOHOL/CHEMICAL DEPENDENCY			REHABILITATION SERVICE		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	173	110	57	180	153	124	151	122	99	58	43	35
1	81	97	102	84	95	107	99	107	108	82	80	77
2	40	47	54	33	36	41	31	47	55	71	75	67
3	12	30	46	9	21	23	17	16	21	40	40	55
4	6	6	17	8	4	14	11	11	9	16	19	23
5	3	10	16	1	7	6	3	8	9	11	15	13
6-10	3	19	17	7	7	10	5	9	19	23	29	29
11+	8	9	21	4	5	5	9	8	10	25	27	31

Note: The total number of MSAs in 1982 was 326, with 328 in 1984 and 330 in 1986.

TABLE 7

DISTRIBUTION OF MSAs BY THE NUMBER OF BED ACCOMMODATIONS OF A SELECTED TYPE, 1982-86

	MEDICAL/SURGICAL INTENSIVE CARE BEDS			CARDIAC INTENSIVE CARE BEDS			NEONATAL INTENSIVE CARE BEDS		
	Number of MSAs			Number of MSAs			Number of MSAs		
Number of Units in MSA	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	6	1	6	63	61	65	146	132	111
1	30	27	25	83	81	103	105	106	127
2	65	63	67	63	75	64	40	40	37
3	54	51	51	36	28	21	15	25	20
4	43	42	45	19	15	19	9	10	12
5	24	32	27	12	14	10	3	6	9
6-10	58	53	51	25	33	30	4	5	10
11+	46	59	58	25	21	18	4	4	4

	BURN CARE BEDS			REHABILITATION CARE BEDS			ALCOHOL/CHEMICAL DEPENDENCY CARE BEDS		
	Number of MSAs			Number of MSAs			Number of MSAs		
Number of Units in MSA	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	233	232	229	209	176	145	180	328	330
1	79	78	84	74	96	101	103	0	0
2	10	14	11	25	29	38	20	0	0
3	0	3	5	5	9	16	7	0	0
4	2	0	0	5	5	10	3	0	0
5	2	1	1	2	5	5	4	0	0
6-10	.	.	.	4	5	10	5	0	0
11+	.	.	.	2	3	5	4	0	0

Note: The total number of MSAs in 1982 was 326, with 328 in 1984 and 330 in 1986.

TABLE 8

DISTRIBUTION OF MSAs BY THE NUMBER OF COMPLEXITY-EXPANDING SERVICES, 1982-86

Number of Units in MSA	OPEN-HEART SURGERY			CARDIAC CATHETERIZATION			HEMODIALYSIS			ORGAN TRANSPLANT		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	134	124	114	87	79	56	40	34	31	205	200	209
1	86	92	90	104	101	105	124	114	110	67	73	68
2	41	45	50	48	52	61	70	66	74	29	26	21
3	20	24	28	31	30	37	27	37	34	8	17	14
4	15	10	6	11	17	16	19	19	17	6	2	7
5	9	13	15	11	11	9	4	11	13	5	3	3
6-10	17	14	20	20	25	31	20	22	23	4	7	7
11+	4	6	7	14	13	15	22	25	28	2	0	1

Number of Units in MSA	MEGAVOLTAGE RADIATION THERAPY			DIAGNOSTIC ULTRASOUND FACILITY			NUCLEAR MAGNETIC RESONANCE FACILITY			C.T. SCANNER		
	Number of MSAs			Number of MSAs			Number of MSAs			Number of MSAs		
	1982	1984	1986	1982	1984	1986	1982	1984	1986	1982	1984	1986
0	63	55	50	2	0	1	319	262	201	14	4	1
1	149	154	160	28	31	23	5	45	64	96	54	44
2	42	43	44	78	64	68	2	13	28	92	85	79
3	25	28	20	51	45	43	0	5	10	36	52	51
4	8	8	11	43	40	43	0	1	12	22	37	32
5	11	9	9	20	31	33	0	0	9	10	15	25
6-10	18	20	27	56	59	61	0	2	5	23	33	47
11+	10	11	9	48	58	58	0	0	1	33	48	51

Note: The total number of MSAs in 1982 was 32, with 328 in 1984 and 330 in 1986.

TABLE 10

DETERMINANTS OF HOSPITAL ADOPTION OF CT-SCANNERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.71	-8.18	-.44	-1.74
PPS Gain	--	--	-.051	-.10
Medicare Dependence[b]	.12	2.28	.10	.82
Herfindahl[b]	-.018	-.71	-.064	-1.17
Percent of Other County Hospitals with CT-SCAN[b]	--	--	-.00049	-.88
Total Margin[b]	--	--	.21	2.01
Medicare Casemix[b]	.46	6.58	.44	2.33
Percent Complexity-Enhancing Services[b]	--	--	.64	4.60
Member Multi-Hospital System[b]	-.011	-.92	-.017	-.59
Beds[b,c]				
50-99	.099	6.50	.19	6.00
100-199	.40	23.14	.32	7.16
200-299	.66	29.29	.34	4.13
300-399	.77	26.97	.37	1.84
>400	.78	25.26	.013	.04
Control[b,d]				
Government	-.017	-1.31	.0039	.14
For-Profit	.0023	.14	.015	.35
Teaching Status[b,e]				
Minor Teaching	-.0075	-.39	-.18	-2.51
Major Teaching	.000072	.002	-.16	-.61

TABLE 10 (continued)

DETERMINANTS OF HOSPITAL ADOPTION OF CT-SCANNERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.045	.88
10%≤ and >-10%	--	--	.041	1.11
-10%≤ and >-30%	--	--	.010	.35
Area Characteristics[b]				
Per Capita Income x10^{-6}	7.4	2.23	9.1	1.15
Population Density x10^{-5}	-1.3	-3.18	-4.8	-2.49
Hospital Wages	.24	3.64	.045	.22
Urban	-.0078	-.37	-.027	-.50
MDs Per Capita	6.72	.89	.35	.02
R^2	.50		.18	
F	230.70		10.90	
N	4222		1271	

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[a] Sample is limited to TEFRA nonadopters.

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 11

DETERMINANTS OF URBAN HOSPITAL ADOPTION OF NUCLEAR MAGNETIC RESONANCE IMAGERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.019	-.33	-.24	-1.43
PPS Gain	--	--	-.24	-.51
Medicare Dependence[b]	.049	1.26	-.093	-.91
Herfindahl[b]	-.050	-1.68	-.067	-.98
Percent of Country Hospitals with NMR[b]	--	--	-.00082	-.64
Total Margin[b]	--	--	-.0078	-.09
Medicare Casemix[b]	.058	1.33	.16	1.37
Percent Complexity-Enhancing Services[b]	--	--	.28	4.08
Member Multi-Hospital System[b]	.0024	.28	-.0035	-.16
Beds[b,c]				
50-99	-.0047	-.28	-.044	-1.02
100-199	-.0088	-.54	-.045	-1.00
200-299	-.020	-1.13	-.044	-.86
300-399	-.011	-.58	-.07	-1.26
>400	.018	.089	.039	.62
Control[b,d]				
Government	-.00048	-.04	-.053	-1.87
For-Profit	.0060	.54	.027	.97
Teaching Status[b,e]				
Minor Teaching	-.0034	-.33	.0010	.04
Major Teaching	.084	3.75	-.028	-.40

TABLE 11 (continued)

DETERMINANTS OF URBAN HOSPITAL ADOPTION OF NUCLEAR MAGNETIC RESONANCE IMAGERS

	PRE-PPS		POST-PPS[a]	
	Dependent Variable = 1 if adopted by TEFRA = 0 Otherwise		Dependent Variable = 1 if adopted by PPS 3 = 0 Otherwise	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.023	.62
10%≤ and >-10%	--	--	.057	1.88
-10%≤ and >-30%	--	--	.0041	.15
Area Characteristics[b]				
Per Capita Income $x10^{-6}$	-2.9	-1.21	-2.2	-.36
Population Density $x10^{-5}$	-.42	-1.89	-2.5	-3.07
Hospital Wages	-.0040	-.10	.13	1.18
MDs Per Capita	13.71	3.19	2.64	.27
R^2	.026		.14	
F	3.13		4.96	
N	1995		750	

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[a] Sample is limited to TEFRA nonadopters.

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 12

DETERMINANTS OF NUMBER OF HOSPITAL COMPLEXITY-ENHANCING SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-4.57	-10.53	-.24	-.45
PPS Gain	--	--	-4.33	-3.32
Medicare Dependence[b]	.38	1.42	.48	1.62
Herfindahl[b]	-.0024	-.02	-.081	-.60
Average Number Services, Neighboring Hospitals[b]	.0099	.67	.018	1.18
Total Margin[b]	--	--	.40	1.62
Medicare Casemix[b]	4.97	14.23	.93	2.26
Member Multi-Hospital System[b]	.10	1.71	.012	.18
Percent Complexity-Enhancing Services[b]	--	--	-6.72	-13.13
Square of Percent Complexity-Enhancing Services[b]	--	--	4.23	8.01
Beds[b,c]				
50-99	1.14	14.89	.60	6.96
100-199	2.84	33.13	.92	8.27
200-299	4.61	41.25	1.24	8.32
300-399	5.80	41.64	1.28	6.98
>400	7.38	48.39	1.43	6.98
Control[b,d]				
Government	-.052	-0.79	-.056	-.82
For-Profit	-.17	-2.04	-.17	-1.80
Teaching Status[b,e]				
Minor Teaching	.27	2.88	.019	.18
Major Teaching	1.01	4.99	-.33	-1.15

TABLE 12 (continued)

DETERMINANTS OF NUMBER OF HOSPITAL COMPLEXITY-ENHANCING SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.34	3.02
10%≤ and >-10%	--	--	.36	4.16
-10%≤ and >-30%	--	--	.23	3.18
Area Characteristics[b]				
Per Capita Income x10^{-6}	-6.2	-.38	10.05	.56
Population Density x10^{-5}	-6.0	-2.97	-7.09	-2.09
Hospital Wages	1.54	4.81	.061	.15
Urban	-.23	-2.19	.073	.64
MDs Per Capita	65.31	1.65	-27.52	-.73
R^2	.74		.15	
F	572.1		11.6	
N	3926		1746	

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[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

TABLE 13

DETERMINANTS OF NUMBER OF HOSPITAL OUTPATIENT SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
Constant	-.13	-.37	2.05	3.45
PPS Gain	--	--	-4.52	-3.10
Medicare Dependence[b]	-.81	-3.77	.19	.58
Herfindahl[b]	.18	1.61	.25	1.58
Average Number Services, Neighboring Hospitals[b]	.11	6.49	.030	1.30
Total Margin[b]	--	--	-.029	-.11
Medicare Casemix[b]	2.25	7.99	-.61	-1.35
Member Multi-Hospital System[b]	.10	2.04	0.37	.50
Percent Outpatient Services	--	--	-4.57	-6.23
Square of Percent Outpatient Services	--	--	.30	.35
Beds[b,e]				
50-99	.27	4.41	.077	.84
100-199	.61	8.76	.26	2.47
200-299	1.03	11.43	.39	2.79
300-399	1.40	12.39	.50	2.87
>400	1.56	12.60	.87	4.69
Control[b,d]				
Government	-.21	-3.91	-.21	-2.75
For-Profit	-.47	-6.78	-.28	-2.63
Teaching Status[b,e]				
Minor Teaching	.49	6.36	.13	1.06
Major Teaching	.57	3.50	.47	1.44

TABLE 13 (continued)

DETERMINANTS OF NUMBER OF HOSPITAL OUTPATIENT SERVICES

	PRE-PPS		POST-PPS	
	Dependent Variable = number of services in TEFRA		Dependent Variable = change in number of services TEFRA-PPS3	
	Coeff.	t-stat	Coeff.	t-stat
TEFRA-PPS3 Change in Discharges[f]				
>10%	--	--	.082	.64
10%≤ and >-10%	--	--	.032	.34
-10%≤ and >-30%	--	--	.095	1.15
Area Characteristics[b]				
Per Capita Income $x10^{-6}$	24.40	1.82	57.8	2.86
Population Density $x10^{-5}$	-2.18	-1.33	-4.04	-1.06
Hospital Wages	.36	1.40	-.16	-.35
Urban	-.12	-1.39	.16	1.24
MDs Per Capita	24.84	.81	-53.17	-1.30
R^2	.33		.17	
F	102.4		13.5	
N	3933		1749	

---

[b] Measured in the TEFRA year.

[c] Omitted category is ≤50 beds.

[d] Omitted category is voluntary.

[e] Omitted category is nonteaching.

[f] Omitted category is ≤-30%.

REFERENCES

Berry, R.E., Jr. "On Grouping Hospitals for Economic Analysis." Inquiry, 10, December 1973, 5-12.

Russell, Louise B. "Prospective reimbursement and new hospital services." Journal of Health Economics, 3, No. 1, 1984, 77-81.

Russell, Louise B. Technology in Hospitals: Medical Advances and Their Diffusion. Washington, D.C.:The Brookings Institution, 1979.

Romeo, A., J. Wagner, and R. Lee, "Prospective Reimbursement and the Diffusion of New Technologies in Hospitals," Journal of Health Economics 3(1984): 1-24.

Hillman, B., "Government Health Policy and the Diffusion of New Medical Devices," Health Services Research 21:5 (Dec. 1986): 681-711.

Luft, H. et al., "The Role of Specialized Clinical Services in Competition Among Hospitals," Inquiry 23 (Spring 1986): 83-94.

Shortell, S. et al., "Diversification of Health Care Services: The Effects of Ownership, Environment, and Strategy," in Advances in Health Economics and Health Services Research 7 (JAI Press, 1987): 3-40.

Lee, R. and D. Waldman, "The Diffusion of Inovations in Hospitals: Some Econometric Considerations," Journal of Health Economics 4 (985): 373-380.

Maddala, G., Limited-Dependent and Qualitative Variables in Econometrics (Cambridge University Press, 1983).

Feder, J., J. Hadley, and S. Zuckerman, "How Did Medicare's Prospective Payment System Affect Hospitals?", New England Journal of Medicine 317:14 (October 1, 1987): 8678-873.

Love, J. et al., "The Decision to Seek an Exemption from PPS," Journal of Health Economics 7(1988): 165-171.

Bowen, Otis R., M.D., Secretary Department of Health and Human Services. Report to Congress on: The Impact of the Medicare Hospital Prospective Payment System, 1986 Annual Report.

Hendricks, Ann, Jerry Cromwell, et al., "The Prospective Payment System's Impacts or Rural Hospital," Needham, MA, The Center for Health Economics Research, September 1988.

Prospective Payment Assessment Commission. Medicare Prospective Payment and the American Health Care System: Report to Congress. June 1988.

Prospective Payment Assessment Commission. Report and Recommendcations to the Secretary, U.S. Department of Health and Human Services. April 1986.

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PROSPECTIVE PAYMENT SYSTEM EVALUATION STUDIES--

THE IMPACT OF MEDICARE'S PROSPECTIVE PAYMENT SYSTEM ON MEDICAL DEVICE INNOVATION

Working Paper

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THE IMPACT OF MEDICARE'S
PROSPECTIVE PAYMENT SYSTEM
ON
MEDICAL DEVICE INNOVATION

1.0 INTRODUCTION

1.1 PPS Incentives

In the Fall of 1983, the Health Care Financing Administration began implementing its new Prospective Payment System (PPS) in hospitals nationwide. Fixed payment rates were established by Diagnosis Related Group (DRGs) that covered all the costs incurred for an admission. The system was prospective in that no year-end settlements were to be made for actual hospital costs that were over or under the fixed rates. This put the hospitals almost completely at risk for additional costs incurred for a given patient or for a class of patients within a DRG.

Under the previous retrospective cost-based system, if a hospital adopted a new technology, its capital and operating costs were included in its cost base and Medicare paid its share of these costs irrespective of the overall utilization of the equipment. So long as Medicare's share of costs did not change, it would still pay a constant percentage of the equipment's total costs even if the machine was only half utilized. Now, under fixed rates, the hospital only receives payment upon discharge. If Medicare discharges fall so do payments, leaving the hospital at greater risk of covering underutilized equipment and beds.

The direct effect of greater financial risk should be a reduction in the hospital's demand for new facilities, services, and technologies. Declining hospital demand, in turn, should have repercussions on the medical device industry. Most directly, it should reduce spending on existing and new innovations, which in the longer run should slow down the rate of technical innovation in medicine--particularly in an inpatient setting. Public concern over maintaining a "first class" health care sector is therefore crucially linked to PPS effects on medical device R & D.

Although the direct effects of PPS on innovation are clear, several indirect effects make absolute predictions less so. First, capital costs were excluded from PPS and are being paid on a cost basis, albeit with a 15 percent roll back across the board. Coupled with the remarkable declines in inpatient utilization, capital passthroughs may have produced a strong bias towards investment in equipment and the substitution of capital for labor where possible.

Second, the hospital industry has done very well on average during the implementation of PPS in spite of unprecedented volume declines. Operating and total margins were at historical highs in the mid-1980s, providing hospitals with substantial internal reserves. As most institutions are non-profit, it is likely that short-run profits have been reinvested in buildings and equipment to reduce operating costs or make the hospital more competitive.

Third, now that hospitals are paid by Medicare only by admitting patients, the financial incentives to attracting patients are reinforced. Whereas under cost-based reimbursement hospitals could follow an indifferent policy towards growth or decline with all their costs covered retrospectively, now any admission declines add significantly to the financial risk of closure or merger. Hospitals compete for patients primarily by attracting admitting physicians. Providing these physicians with the very latest in medical technology is an important aspect of this competition. This would lead to a greater emphasis on adopting new technologies. Whether this "admissions effect" more than offsets the depressing "risk effect" is an empirical question.

Besides the question of the overall rate of adoption of new technologies, two other issues are worth mentioning. First, in setting up payments at the DRG level, Medicare is signaling the hospital industry, physicians, and ultimately the manufacturers of medical devices, which kinds of patients are the most lucrative to treat. Historically, the highest paying DRGs were also those incurring the highest costs, either due to long stays (e.g., psychiatric patients), intensive ICU and operating room use (e.g., cardiac bypass patients), and/or technology-intensive (e.g., renal failure patients). Generally, the higher the DRG payment, the less the financial risk of adopting and using a particularly expensive medical device or diagnostic technology. Conversely, very low paying DRGs may become "orphans" with little financial incentive to introduce innovative, but expensive, technologies.

A second issue concerns the problems of partial regulation. In setting DRG rates only for inpatients, the PPS encourages shifts of care to outpatient settings under certain circumstances. While this was an expressed intention of the legislation, it may systematically bias technical innovation in unexpected ways, or in ways that are not always cost effective. Most new technologies were limited in the past to the hospital, and a natural screen to access existed; that is, a patient had to be admitted first to be a candidate for using the technology. Now, PPS encourages hospitals to diagnose and treat as much as possible on an ambulatory basis, reinforced by PRO sanctions. Physicians therefore are demanding downscaled versions of the inpatient equipment and may be performing far more tests and procedures than would have occurred previously on an inpatient basis. Although this may improve patient access and health outcomes, it may also result in greater inappropriate, high-tech, care and little or no overall cost savings to the Medicare program.

1.2 The Major Policy Question

The major question facing policy makers in general and HCFA decision makers in particular is how to develop and update DRG rates in a way that leads to a more appropriate level of technology innovation and diffusion, as well as how to best target the innovation by type of illness and site of care. Answers to this question will be complicated and probably never completely definitive. They will also take many years of research, in part because we know so little about the long term effects of prospective payment on medical device R & D.

1.3 Organization of Paper

This paper is an early attempt at drawing inferences of PPS effects on innovation. While we do present some quantitative information on recent trends in R & D spending and the structure of the device industry in the following section, most of the work is conceptual and relies upon a few case study interviews with five manufacturers. The firms ranged in size from industry giants to those with $40-50 million in annual sales. These products were of the hi-tech variety, including pacemakers, heart valves, infusion pumps, and ultrasound imagers. At this point, the case studies excluded very small (less than $5 million) start-up ventures, so any comments about the impact of PPS on these operations are inferential, based on observations of larger manufacturers.

An informal topic questionnaire was used in interviewing marketing, R & D, and corporate decision makers about these areas. Emphasis was placed on PPS effects on R & D planning and changes in the way firms market to hospitals and physicians. Because each firm sees the market differently, it is difficult from just a few interviews to generalize, but certain themes reoccur that help one draw limited inferences about trends and the strength of underlying forces. The following are a list of the topic areas covered in our interviews.

- DRG incentives
- Updating and recalibrating DRGs
- R & D spending and strategic planning

- Firm size, innovation, and PPS effects
- Hospital purchasing process
- Hospital vs. physician incentives
- Shifts to outpatient sites
- FDA review and HCFA reimbursement coverage
- Product liability
- Underlying computer and biotech revolutions.

2.0 TRENDS IN THE STRUCTURE AND GROWTH OF THE MEDICAL DEVICE INDUSTRY

2.1 Trends in Industry Growth and Structure

The medical device industry has grown from less than $1 billion in sales in 1958 to nearly $16 billion in 1982 (see Table 1). This figure represents an increase of 1478 percent. After adjustment for inflation, sales still increased sixfold during that period (OTA, 1986, p. 1-1). The growth of the medical devices industry has surpassed that of all other comparable industries. Really explosive growth occurred among x-ray and electromedical equipment (4,174 percent since 1958) and surgical and medical instruments (2,892 percent).

Employment growth (see Table 2) has also been strong, rising 220 percent between 1958 and 1982. The fact that the real value of shipments grew 6-fold over the same period implies phenomenal labor productivity growth in the sector.

Table 3 shows the 4- and 8-firm concentration ratios for 1963 and 1977 by SIC code (1982 data were unable). The table shows a large increase in the number of firms over 15 years, with a fairly strong decline in industry concentration at this level of aggregation. While this might be construed to mean a more competitive industry, the real meaning is more subtle. The fact of the matter is that each industry SIC code is not one industry but many with few firms producing close substitutes. This is better shown by decomposing sales to hospitals.

2.2 Sales to Hospitals

Table 4 gives a breakdown of medical device and commodity shipments to hospitals alone for 1982, the last year of complete data. Of the estimated $15.7 billion total reported in Table 1, $7.8 billion went to hospitals. This number is slightly incomparable in that total U.S. shipments include non-medical items such as hospital "furniture" (e.g., operating room tables) that were not included in Table 4. They also exclude rarely purchased items such as CAT scanners. The nearly $8 billion, however, is probably a more accurate estimate of true device expenditures going to hospitals.

It is clear from Table 4 that the device "industry" is not a single industry but an agglomeration of many industries producing medical supplies and devices. Thus, we should be careful to generalize about the effects of PPS, technology change, or any other factor on the industry as a whole. It is also clear that each subindustry is far more concentrated than Table 3 would suggest, as shown by the 4- and 8-firm concentration ratios.

TABLE 1

SHIPMENTS OF MEDICAL DEVICES IN CURRENT DOLLARS, 1958-1983, (Millions Of Dollars)

	SHIPMENTS						ANNUAL PERCENT CHANGE[a]					
Year	X-ray and Electromedical Equipment	Surgical and Medical Instruments	Surgical Appliances And Supplies	Dental Equipment And Supplies	Ophthalmic Goods	Total	X-ray and Electromedical Equipment	Surgical and Medical Instruments	Surgical Appliances And Supplies	Dental Equipment And Supplies	Ophthalmic Goods	Total
1983[b]	$4,060	$3,890	$5,990	$1,474	na	$15,415[c]	13	12	13	7	--	12[c]
1982	3,590[b]	4,085	5,667	1,112	1,287	15,741	12	29	20	-15	2	-11
1981	3,203	3,158	4,734	1,314	1,263	13,672	27	17	23	5	4	18
1980	2,527	2,697	3,861	1,252	1,212	11,549	10	14	14	17	8	13
1977	1,885	1,883	2,597	787	972	8,074	34	14	12	14	11	16
1972	444	962	1,454	409	568	3,837	14	15	12	13	6	12
1967	233	475	838	221	426	2,193	13	14	9	11	12	11
1963	144	284	597	148	273	1,446	9	17	5	5	7	8
1958	95	130	462	116	194	997	--	--	--	--	--	--

na = not avaliable

[a] For inconsecutive years, the compound annual growth rate was calculated.

[b] Estimated.

[c] Total does not include shipments of ophthalmic goods.

Source: U.S. Department of Commerce, Bureau of Industrial Economics, Washington, D.C., Jan. 1984; Marcus, P., U.S. Department of Commerce, Washington, D.C., personal communication, Jan. 1984.

*Taken from office of Technology Assessment, Federal Policies And The Medical Devices Industry, October 1984.

TABLE 2

EMPLOYMENT IN THE MEDICAL DEVICES INDUSTRY, 1958-1983, (Thousands)

Year	X-ray and Electromedical Equipment	Surgical Medical Instruments	Surgical Appliances And Supplies	Dental Equipment And Supplies	Ophthalmic Goods	Total
1983	42.7[a]	55.7[a]	67.5[a]	18.0[a]	na	183.9[b]
1982	41.5[a]	56.9	68.8	15.5	26.3	209.0
1981	41.5	54.6	64.9	17.4	26.4	204.8
1980	38.8	51.3	61.8	16.7	29.4	198.0
1977	30.9	43.2	53.9	16.3	30.0	174.3
1972	12.1	34.5	43.9	12.4	26.6	129.5
1967	7.9	22.0	35.2	10.2	25.6	100.9
1963	6.2	15.1	28.3	8.0	20.3	77.9
1958	5.3	10.3	24.2	7.2	18.2	65.2

[a] Estimated.

[b] Total does not include employement in the ophthalmic goods industry.

Source: U.S. Department of Commerce, Bureau of Census, Annual Survey of Manufactures, Statistics for Industry Groups and Industries, for years 1958, 1963, 1967, 1972, 1977 and 1981; U.S. Department of Commerce, Bureau of Industrial Economics, 1984 U.S. Industrial Outlook, Jan. 1984.

*Taken from Office of Technology assessment, Federal Policies and the Medical Devices Industry, October 1984.

TABLE 3

MARKET SHARE OF VALUE OF MEDICAL DEVICES SHIPMENTS BY LEADING FIRMS, 1977 AND 1963

Industry Segment	Year	Total Number Of Firms	Percent Market Share	
			4 Leading Firms	8 Leading Firms
X-ray and Electromedical Equipment	1977	212	32	51
	1963	56	67	79
Surgical And Medical Instruments	1977	575	32	48
	1963	255	49	58
Surgical Appliances And Supplies	1977	1,017	38	49
	1963	525	49	58
Dental Equipment And Supplies	1977	507	33	46
	1963	267	37	50
Ophthalmic Goods	1977	593	45	56
	1963	211	53	62

Source: U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, as cited in U.S. Department of Health and Human Services, Food and Drug Administration, Office of Planning and Evaluation, Baseline Data on the Availability of Medical Devices and In-Vitro Diagnostic Products, OPE Study 54, Washington, D.C., 1980, for years 1963 and 1977.

*Taken from office of Technology Assessment, Federal Policies And The Medical Devices Industry, October 1984.

TABLE 4

SALES OF SELECTED MEDICAL DEVICES TO HOSPITALS BY DEVICE CATEGORY, 1982

Category	Product	Sales To Hospitals (thousands of dollars)	Percent Market Share	
			4 Leading Firms	8 Leading Firms
X-ray and electromedical equipment	X-ray supplies	$777,366	89.3	98.2
	Radiological catheters and guide wire	135,878	85.3	92.8
	Pacemakers and other cardiovascular products	499,999	73.7	88.9
	Electrosurgical supplies	48,552	58.9	82.6
Surgical and medical instruments	Surgeons' needles	4,310	96.5	99.6
	Blood collection supplies	57,845	96.4	99.1
	Thermometers	31,426	78.8	92.3
	Surgical instruments	294,284	68.1	81.2
	Syringes and needles	331,054	65.7	80.9
	Catheters, tubes, and allied products	235,445	60.8	81.6
	Diagnostic instruments	69,549	59.5	77.8
Surgical appliances and supplies	Sutures	286,635	99.9	100.0
	Ostomy products	13,842	97.9	99.6
	Surgical packs and parts	174,123	84.1	95.1
	Maternity products	26,869	82.3	91.8
	Dialysis supplies	97,677	81.5	93.3
	Cardiopulmonary supplies	71,176	79.4	98.0
	Sponges	174,768	78.9	88.4
	Bandages, dressings and elastic	172,303	77.3	87.5
	Orthopedic supplies	302,283	74.5	83.8
	Parenteral supplies	701,106	72.6	91.9
	Urological products	198,970	71.7	86.8
	Sterilizer supplies	88,846	71.4	83.5
	Cast room supplies	39,836	62.2	78.6
	Disposable kits and trays	258,317	46.7	63.1
	Respiratory therapy	245,890	45.1	67.4
	Garments, textiles, and gloves	592,254	43.7	61.1
Ophthalmic goods	Ophthalmic-related products	83,649	67.9	93.3
Other	Solutions	872,985		
	Medical supplies	420,702		
	Chemicals and soaps	153,946		
	Paper products	113,738		
	Gases	109,933		
	Underpads	55,259		
	Identification supplies	31,517		
	Elastic goods	24,932		
	Rubber goods	7,281		
TOTAL		$7,804,545		

Source: IMS America, Ltd., Rockville, MD., unpublished data, 1983.

*Taken from office of Technology Assessment, Federal Policies And The Medical Devices Industry, October 1984.

2.3 Trends in R & D Spending

Research and development is the financial engine that supports innovative activity in the health care field. Exhibit 1 summarizes the 10-year trend in health R & D from all sources on all health products, not just medical devices. In 1977, the country was spending roughly $5.6 billion annually on R & D; by 1987 the figure was over $16 billion. The NIH share has steadily declined while private industry's share rose from 29 to 42 percent. "In constant dollars, R & D expenditures have grown 6 percent annually for the past five years. This represents a faster growth than any other five-year period since 1960." (Health Affairs, Summer 1987, p. 93)

Table 5 shows that during the period of 1974 to 1980, total industrial R & D in the more narrowly defined medical devices industry grew from $142 to $349 million, a growth of nearly 150 percent. In 1974 dollars this still represents a growth of 35 percent. The amount of federal support for industrial R & D never reached more than 3 percent.

2.4 Trends in Innovations and Patients

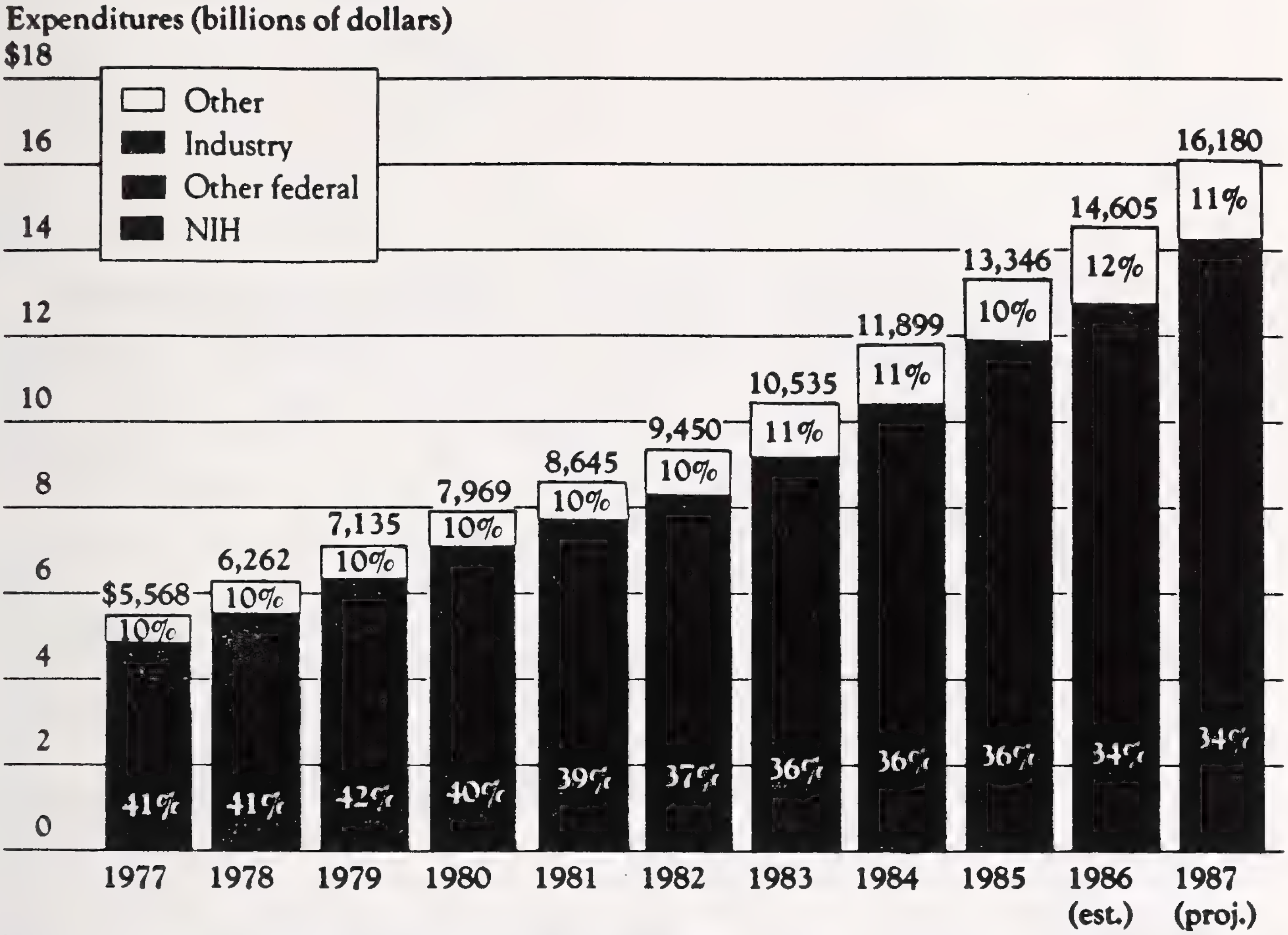
The Food and Drug Administration (FDA) defines a medical device as "...any instrument, apparatus, or similar or related article that is intended to prevent, diagnose, mitigate, or treat disease or to affect the structure or the function of the body (OTA, 1984, p. 1-3)." This definition excludes drugs because they achieve their effects through chemical action within or on the body.

The need for regulation in the medical devices industry lies in the inherent difference between the market for medical devices and other products. Consumers do not have the knowledge and expertise to evaluate and differentiate between medical technologies that they might have with other products. Therefore, they must depend on medical professionals to inform them about the medical devices and services available to them, as well as how these devices can help them. The problem is that, to a large extent, even medical professionals often lack the expertise to assess sophisticated medical devices. And with so many new innovations, it is difficult to keep up with the availability of new devices, let alone to have a working familiarity with their purposes and function. Thus, a regulatory body like the FDA takes the responsibility for making sure that only those devices that are screened and tested for safety are marketed to medical professionals who will in turn make them available to consumers.

The FDA was first authorized to regulate medical devices in the Federal Food, Drug, and Cosmetic Act of 1938. This law, recognizing the implications of unsafe medical devices for human use, required premarketing screenings.

Exhibit 1

National Support For Health R&D By Source, 1977–1987



Source: National Institutes of Health, *NIH Data Book* (1987).

*Taken from Health Affairs, Summer, 1988, p.176.

TABLE 5

SOURCES OF SUPPORT FOR INDUSTRIAL R & D IN FIVE SIC MEDICAL DEVICES CODES, 1974-80

Year	Total Industrial R & D (in thousands)	1974 Real Dollars	Federal Support (Percent Of Total)
1974	$142,080		2.6%
1975	168,884	$154,740	2.9
1976	198,874	172,249	2.7
1977	228,677	186,091	2.5
1978	273,794	206,957	2.1
1979	291,751	198,214	1.6
1980	348,707	208,687	2.0

Note: The five Standard Industrial Classification (SIC) codes include x-ray and electromedical equipment; surgical and medical instruments; surgical appliances and supplies; dental equipment and supplies; ophthalmic goods.

Source: Office of Technology Assessment, Federal Policies and the Medical Devices Industry (October 1984), 79.

*Taken from Health Affairs, Summer 1985.

While the FDA assumed responsibility for regulating medical devices during the Great Depression, it was not until 1976 that its powers were clearly defined. In 1976, the Medical Device Amendments gave the FDA additional power to require that businesses involved in the manufacturing and development of medical devices register with the FDA and list their devices annually. The amendments also gave the FDA the authority to classify medical devices and to impose premarket clearance requirements that reflect the degree of risk of the device. Regulating the testing and marketing of medical devices to ensure their safety and efficacy not only protects consumers but also addresses manufacturers' concerns about quality and shoddy products. (Assessing Medical Technology, 1985, p. 50.)

Medical devices are grouped into one of three regulatory classes differentiated according to their degree of human risk and to the control necessary to ensure their safety and efficacy. Class I devices are regulated by requirements consisting of general controls, such as good manufacturing practices (Russell and Sisk, p. 271). Class II devices are supposed to meet performance standards set by the FDA. Class III devices, those that "...support life, prevent health impairment, or prevent an unreasonable risk of illness or injury," are required to go through a full premarket clearance process (Russell and Sisk, p. 271). Under the 1976 legislation, manufacturers must receive the FDA's premarket approval to market a medical device for the first time.

All post-1976 medical devices require premarket approval unless the manufacturer can prove that the device is "substantially equivalent" to one already approved before the 1976 amendments or that it belongs in Class I or II (Assessing Medical Technology, 1985, p. 50). A device that falls into the Class III category and is not substantially equivalent to a pre-1976 device requires that the sponsor provide information to the FDA relevant to investigations about the product's safety and efficacy. The process involves an Investigational Device Exemption (IDE) and submission of a premarket approval application (PMA). The IDE permits an unapproved device to be used on a limited basis in a controlled environment to collect safety and efficacy data (Assessing Medical Technology, 1985, p. 51). Once the testing is complete, which usually takes several years, the manufacturer submits a PMA that states the results of the investigations. If the FDA finds the device to be safe and efficacious based on the results, it will then approve the PMA. In 1984, the FDA published final rules on medical device reporting. These rules require that manufacturers and importers of medical devices report to the FDA any information indicating that a device may have caused or contributed to a death or serious injury. The median time for processing PMAs is about 10 months.

By year's end 1981, out of 17,000 products submitted after 1976 to the FDA for approval, all but 300 had been found to be "substantially equivalent" to pre-amendments devices. Those devices that were not determined substantially equivalent to already existing ones were automatically placed into Class III. "Based on an FDA survey of 20 manufacturers of various types of medical devices, the cost of bringing a new device to market through the PMA process ranges from $370,000 to $1,025,000 (Assessing Medical Technology, 1985, p. 51)."

In spite of all the regulations, there have been no documented substantial negative effects on the medical devices industry (Russell and Sisk, p.271). A reason for this may be that major sections of the 1976 legislation have not been implemented or are infrequently implemented. No performance standards have yet been developed for Class II devices, and PMAs used for Class III devices have been an infrequently implemented.

The medical device industry's continuing commitment to hi-tech R & D is reflected in the number of patents issued in 1986 for the major categories of medical devices. "Total patents issued [in 1986] increased by 19.5 percent to 2,518; patents for surgery-related devices alone increased by 22.9 percent to 1,932 (Pollard and Persinger, Summer 1987, p. 104)." Even more indicative of hi-tech innovation are the number of IDEs and PMAs (see Table 6), which have steadily increased from 1980-87, showing the continued interest in developing new, but risky, technologies.

TABLE 6

REGULATORY FILINGS AND APPROVALS, 1980-1987

	DEVICES			
Year	IDEs[a]	PMAs[b]	Suppl[c]	510ks[d]
1980	63	24	78	2,908
1981	232	32	239	3,381
1982	189	49	238	3,256
1983	187	46	327	3,162
1984	198	43	243	4,262
1985	201	37	377	5,095
1986	213	72	477	5,359
1987	224	46	565	4,992

[a] Investigational device exemptions.

[b] Premarket approval.

[c] Supplemental applications.

[d] 510ks used for minor changes technology.

Source: Food and Drug Administration, New Drug Evaluation: Statistical Report, NTIS PB87-195335 (Rockville, Md. FDA, April 1987); Pharmaceutical Manufacturers Association; and FDA, Office of Device Evaluation Center for Devices and Radiologic Health, Annual Report, Fiscal Year 1987.

*Taken from Health Affairs, Summer 1988.

3.0 HOSPITAL RESPONSES TO FIXED DRG RATES

With these general quantitative trends as background, let us now review the subjective responses of device manufacturers to questions concerning PPS impacts on sales and R & D. Quotes reflect their opinions which have not been verified with objective information, but we present them nonetheless, confident in their approximate truth.

3.1 Prices

Manufacturers were almost unanimously agreed that the immediate response of hospitals to PPS was to invoke price freezes on practically all purchases, ranging from reusable commodities to pacemakers. "Medical product prices as a whole [that] were rising 7-9 percent annually fell to 2 percent by 1987, with many commodities and devices experiencing no price increases in the last four years." Price discounting became quite prevalent so that there is "no such thing as list prices anymore."

The price "crunch" was especially concentrated in the so-called hi-tech "commodities" like IV bags and other supplies. Manufacturers of these items have had to make multi-million dollar investments in new equipment and methods just to remain cost competitive. This, of course, increased the economic advantage to size, of which more will be said later.

A second response of hospitals besides price discounting was a renewed interest in recycling. For years, the trend had been toward disposables, which involved large inventories but were more convenient. When hospitals could no longer automatically pass on inventory and single-use purchasing costs, administrators became more interested in reusing supplies where possible. For the more esoteric devices like bone fixators and bone growth stimulators, hospitals are now insisting on taking a few devices on consignment or just-in-time inventorying. They pay, in effect, only when the device is actually used, shifting inventorying costs back to the distributor or manufacturer.

In spite of these very short-run responses, manufacturers do not feel hospitals have really "hit the wall" in their spending on existing or new technologies. High profit margins over the last few years have greatly attenuated the expected decline in demand. Now that margins have begun to fall, however, the inevitable squeeze on manufacturers should begin to have serious effects in the early 1990s.

Although overall demand remained high after the initial price crunch brought on by mass uncertainty surrounding PPS, certain "device intensive" DRGs were hard hit. Pacemakers were one example on the price side, although demand remains strong because of the aging of the population and continual innovation. Prostheses were also especially affected. The market for cochlear implants, for example, is estimated to be one-half to one-tenth what it might have been. When HCFA rejected the addition of a "dual pacemaker DRG," hospital interest waned considerably. At $5,500-6,000, the dual pacemaker is $1,000-1,500 more expensive than the single chamber model. As a result some hospitals use many dual chambers while others buy none at all. This may be partly explained by the fact that the device itself costs more than the total DRG payment in some rural hospitals. It has been alleged that some hospitals provide single chamber "Medicare pacemakers" for its elderly patients and the more sophisticated dual chamber models for its non-Medicare patients.

Another example of how PPS may have modified hospital device purchases is external bone fixators. These devices are used in polytrauma cases and vascular or brain surgery to completely immobilize the bone for an extended time period. They are external rods with steel pins that are surgically inserted into the bone at two ends. Originally, they were made completely from stainless steel, but now include some plastic which reduces their durability. Hospitals have started buying the cheaper models and reusing them more, which lowers demand for the more expensive all-steel models. Furthermore, recycling these expensive devices not only substantially reduces the market even more; it also requires the development of a refurbishing and second warranty industry. Profit margins are naturally far less when providing this maintenance service.

3.2 DRG Effects

While manufacturers would probably agree that DRGs have had more effect at the macro level in terms of hospital demand for equipment, some micro, DRG-specific, effects were mentioned. Very expensive devices without their own DRG, such as cochlear implants, have definitely faced a smaller market. There also is the complaint that the DRG classification system has a definite bias against medical solutions. Surgical DRGs almost always command a higher payment. Thus, when a choice exists of treating the patient medically or surgically, both the hospital and the physician have an incentive to operate. For many devices this has a positive demand effect, but for others, like bone growth stimulators, the opposite may be the case. This lessens the incentive to introduce a complementary new medical device .

Beyond the surgical bias, the extent of Medicare patient dominance of a particular DRG is said to bias device innovation and diffusion. If a DRG's charge weight derives primarily from commercially insured patients, the larger permitted mark-ups encourage investment in diagnosing and treating the underlying illness. If, on the other hand, the DRG is Medicare dominated, the fixed DRG rates may discourage innovation because of a smaller hospital market--both in terms of purchase price and units sold.

Some manufacturers who have not been as affected by DRG fixed payments are very concerned about the spread of DRG-like systems to other payers and other states. Because only Medicare is currently using DRGs on a widespread basis, there appears to be a systematic R & D bias away from "Medicare DRGs." At this point this bias does not seem very serious, but it could have long-run implications unless other payers develop more illness-specific payment methods.

The possibility of "Medicare DRGs" also highlights the fundamental problem of incorporating technical change into a prospective system. Using charges to calibrate payment weights has the theoretical advantage of incorporating new technologies into future rates as they diffuse across hospitals. But the responsiveness of this weighting approach depends upon (a) the overall importance of Medicare in total hospital charges, and (b) the relative Medicare charges in each DRG. Medicare payments currently amount to about 35-40 percent of hospital revenues on average, which places a definite limit on new technology diffusion as high device mark-ups are only passed through in 60-65 percent of charges. Were Medicare's share only 10 percent (like Medicaid), hospitals would be much less sensitive to DRG rates in adopting new technologies. And for some DRGs (e.g., cataract surgery, hemodialysis, cancer), Medicare is far more dominant, which could significantly discourage innovation because total DRG charges will be very insensitive to diffusion to non-Medicare patients.

Another potential bias of PPS on innovation concerns the discharge as the unit of payment. Hospitals are paid under Medicare only if the admit, or readmit, patients. Innovations that might prolong a single admission or raise its costliness are discouraged in favor of devices that shorten stays but may necessitate readmission, or at least make it more likely. Examples of innovations that are less favored by hospitals include implantable drug infusion pumps and specially designed external fixator pins. Cancer infusion pumps cost over $10,000 to implant, but they can reduce the toxic side effects that often require readmission. It is also possible to design external fixator pins so that they can be removed in the outpatient department rather than on an inpatient basis. Selling either of these devices is more difficult today as hospitals do not see it in their financial interest to "spend more now to save later."

It is also important to note that maintaining physicians under a fee for service system does not always provide the desired check and balances against a penny-wise but pound-foolish decision. Orthopedic surgeons may also have incentives to readmit and operate rather than use a device designed to obviate the need for more surgery.

3.3 Visible Devices

Some medical devices appear to have been immune from the depressing effects of DRG prospective payment either because they are highly "visible" or are complementary to "image making DRGs." Magnetic resonance imaging, lithotripters, and laser surgery are examples of visible technologies that bring immediate recognition to the hospital. Not having an MRI unit can put the larger community hospital at a distinct competitive disadvantage with its local rival, not only for patients that might need MRI services, but for other patients as well (and their physicians) who use such visible equipment as key indicators of hospital quality.

Heart valves are one example of a complementary device to the highly prestigious, image enhancing, open heart surgery field. The valves themselves are not particularly visible to either patients or physicians, but the operation in which they play a crucial role is highly visible. The hospital in the community performing open heart surgery is invariably the market leader, attracting patients from a broad market area, not only for open heart but many other kinds of surgery. No administrator is going to quibble over the cost of a valve given the large perceived spillover effects on demand that go beyond open heart surgery itself. "If a renowned heart surgeon likes a particular valve, that's what he gets."

4.0 MEDICAL DEVICE MARKETING UNDER PPS

Prior to the introduction of PPS, manufacturers marketed their devices exclusively to physicians. The arguments they gave almost invariably focused on efficacy, accuracy, speed, convenience, and scope of diagnostic information. This may seem odd in that hospitals, not physicians, actually bought the equipment. Cost-based payment, however, provided little financial constraint and made direct marketing to hospitals almost unnecessary. The effect was to concentrate on incremental improvements ("bells and whistles") attractive to physicians that could not be considered cost effective.

4.1 Marketing "Cost Effectiveness"

PPS has not changed the marketing focus on physicians, at least for hi-tech devices, but it has changed the nature of the argument. Because physicians can no longer argue that equipment costs are a simple cost passthrough, manufacturers must defend their products on a cost effectiveness basis as well. A device can no longer simply be "the best on the market." It must also be the most cost effective--at least from the hospitals' narrow perspective.

Because physicians may not be adept at making such arguments to hospital administrators and purchasing agents, or because they have no financial interest in the hospital's purchasing cost effective devices, manufacturers are marketing more and more to hospitals directly. It is clear that the decision making power has shifted away from purely medical considerations to cost questions as well. Depending on the device, manufacturers have had to develop elaborate technology assessments as marketing tools. In some instances (e.g., bone stimulators) where potential inappropriate use is high, these assessments serve a dual purpose of convincing third party payers to cover the technology.

Manufacturers now approach hospitals from a cost/reimbursement perspective. They inform the hospital of the proper CPT-4, ICD9, and DRG billing codes for the device. As many devices like infusion pumps can be used in over 20 DRGs, they advise on any coverage limitations outside appropriate DRGs and how to maximize reimbursement when the device is covered. This has resulted in device manufacturers hiring DRG coding specialists much like hospitals have hired specialists to maximize DRG payments.

The heightened cost consciousness notwithstanding, there is little evidence that cost effectiveness considerations have permeated the hi-tech, "visible device" world. Hospitals continue to invest in life-saving technologies more or less regardless of their costs because of the greater patient competition and the drive to maintain industry leadership. There has always been a good deal of product and brand name loyalty on the part of physicians, discouraging the entry of other firms. Cardiologists, for instance, show definite loyalty to Hewlett-Packard for cardiac monitoring equipment while radiologists prefer dealing with General Electric for radiological equipment. The basis of this brand loyalty may be related to habit, familiarity with the device, or satisfactory performance in the past. Strong specialist ties naturally leads to a very focused marketing strategy on the part of device manufacturers. By concentrating on specific devices, distribution networks and product loyalty are carefully cultivated over time, locking in the market. It is the essence of this strategy for manufacturers to engineer physician loyalty rather than product superiority, although the product could be of the highest quality as well.

The same cannot be said anymore of hi-tech "commodities" and certainly not of disposables. Hospital purchasing agents almost exclusively make the choice and negotiate prices on simple heart monitors, EKG machines, IV systems, and the like; devices that 10-15 years ago may have been totally within the province of the physician. Market competition has become extreme for a wide variety of these less esoteric devices and disposables. Where "subtle" differences in IV bags and other high tech commodities used to assure market niches and price differentials, PPS has levelled them out, making production and distribution costs the key to success.

4.2 JIT Inventorying

We have already mentioned the spread of consignment and just-in-time inventorying. While most manufacturers abhor having to supply their device only upon patient demand, larger distributors are using it as a way to expand their markets. The effect is to shift inventorying costs back to the manufacturer and depress profit margins.

This trend played an important part in the Baxter-Travenol decision to purchase American Hospital Supply Corporation. Recognizing that hospitals have space problems and high inventory costs, Baxter saw an opportunity to expand their own market for hi-tech devices by acquiring a large commodity distribution system. "At little marginal cost, we can put a few heart valves or pacemakers on the palate containing the hospital's usual disposables. And we can do this on a daily basis everywhere in the country."

4.3 Relative Versus Absolute Accuracy

Even device accuracy is no longer sacrosanct. Whereas under cost-based reimbursement, a device could always be marketed on the grounds of better accuracy, now hospitals are asking, "How much accuracy at how much additional cost?" The "accuracy imperative" in blood and urine testing, in intravenous solutions, etc., had reached the point that physicians couldn't even evaluate the differences, and they certainly had no demonstrable effects on patient outcomes. Fixed payment encouraged administrators to ask their chiefs of the various ancillary services how persuasive were these accuracy arguments put forth by the medical staff. Where the answer came back, "Not very," the hospital stopped accepting the argument at face value and started demanding relative accuracy, i.e., relative to the extra costs and benefits achieved.

4.4 Marketing to "Winning" Hospitals

Most manufacturers have always targetted their marketing to selected hospitals depending on their product and the size of the market. But the potential limits of hospital diffusion of a particular technology were obscured by cost-based reimbursement. Should a 100-bed rural hospital have a CT scanner? A 50-bed hospital? What about 30 beds? As size declines generally so does volume, making the scanner a very expensive purchase on a per use basis. Cost-based payers, however, bore all the risk of underutilization in small institutions, making scanners "marketable" even in the smallest hospitals in the least populated areas.

Under fixed payments, the underutilization risk has shifted almost totally to the hospital, which has had the effect of narrowing the device market and better defining it. This is true both for specific DRGs (as discussed earlier) and well as hospital type and location. Manufacturers know that teaching hospitals are paid better under PPS; they know that all urban hospitals, no matter how small, are paid 20-25 percent more than rural hospitals; and they know that hospitals in certain parts of the country have costs well below the DRG national averages. A few manufacturers are even using NCHSR data on ICD9 admission codes by region to target the marketing of specific devices. Thus, the urban teaching hospital stands at the top of any manufacturer's list of potential customers, and while this was probably always true, the list is much shorter than it used to be. This makes the marketing more focused and competitive. It also concentrates new technology in expensive medical centers. Whether regionalization is cost effective remains to be studied, but the short-run effect is to give an even more preferred position to teaching hospitals.

In spite of this targetting, which should inhibit the rate of technology diffusion across hospitals, several manufacturers were still seeing considerable diffusion to smaller hospitals because neither hospitals nor physicians want to lose patients in such a competitive environment. It is not clear, however, that these hospitals will continue to be able to afford new, underutilized, equipment as profit rates and volumes continue to fall.

5.0 MEDICAL DEVICE R & D STRATEGIES UNDER PPS

Innovation in health care comes from a variety of sources: (1) Physicians working in medical centers on NIH or other public and private grants; (2) Biologists, physicists, geneticists, and other scientists doing basic research within universities and government that yield breakthroughs for commercial application in the private sector; and (3) Basic and applied research in private drug and medical device companies who bring ideas to market. Private companies, being sensitive to the profit motive, are likely to respond first to the financial impact of PPS, with subsequent effects rippling through the entire medical research community.

5.1 Underlying Factors in R & D Spending

In spite of greater risk, none of the device manufacturers that we talked to said they had cut back on R & D spending since PPS was implemented. This is not to say that they have been unaffected by the system; far from it. But there are important reasons why the global effects have been muted.

First, one should not forget the underlying demographics. The U.S. population not only is growing, but is aging as well. The aging of the population places a very solid floor under future demand--at least as perceived by device manufacturers. Long-term "growth" areas such as cancer, heart, dialysis, organ transplants, laser and cataract surgery, are all dependent on an aging population. PPS may slow down market growth, but it certainly will not eliminate it. And R & D planning, if anything, is based on very long-term forecasts.

Further enhancing the long-term forecasts in the eyes of manufacturers is the trend towards physician specialization. Cardiologists want to implant pacemakers and use ultrasound, thoracic surgeons want to use heart valves; ophthalmologists want to perform cataract surgery; anesthesiologists want to insert Swans-Ganz catheters; and gastroenterologists want to use endoscopes. Thus, while technical innovation encourages young physicians to specialize for intellectual and financial reasons, it also seems true that specialization reinforces continued investment in new innovations.

Further adding to the demographic trends are the general trends in technology worldwide that can be easily adapted to medicine. Computer miniaturization permits the use of all kinds of implantable devices, for example, which justifies large R & D spending. Ultrasound imaging is another area that has widespread uses in other industries with obvious adaptations to diagnosing illnesses. So long as these and other global technology trends (biotech is another example) continue, R & D spending will remain high in spite of attempts to constrain health care spending overall.

5.2 Targetting R & D To DRGs

In spite of a lack of evidence that PPS has reduced overall R & D spending on medical devices, there is considerable anecdotal evidence that DRG payments have altered the decision-making process. Firms' overall R & D strategy is no longer driven by technology alone, "nor is there any debate anymore over the role of technology versus the market in guiding R & D planning." The first question a manufacturer now asks is, "Is the device a hospital-specific product?" If the answer is yes, then "What is the DRG rate?" If the answer to these two questions is yes, then the proposed innovation had better demonstrate overwhelming cost savings to hospitals or be of demonstrably better quality than existing units.

The next question asked is, "How large is the market?" This becomes a more crucial question now because producers are no longer guaranteed an adequate market at any price. That is, they cannot always be assured of recovering their R & D and manufacturing/distribution costs through high mark-ups on a limited number of units. Large volume DRGs become prime targets. There were over 275,000 pacemakers implanted worldwide last year, which at $4-5,000 each make it a billion dollar device market annually. There were nearly 300,000 discharges in the arrhythmia DRGs 138-9 in the U.S. alone. Of these, 116,000 involved atrial arrhythmias that might be eligible for defibrillator devices. It is numbers like these that naturally fall out of DRG reporting at the national level and are being used by firms to forecast new markets and concentrate R & D efforts.

Another example is gall bladder surgery. Up to 85 percent of cholecystectomies may be avoidable using solvents or catheters to dissolve or grind up the stones. This is a market worth going after, even if a firm captures only one-third of the business.

What else do manufacturers consider in targetting their R & D? In talking with hospitals, they identify chronic DRG losers and design devices to lower operating costs. Computerization of medical records to reduce labor costs is a familiar example, but the application extends to intra and interhospital transmission of diagnostic information as well. According to one manufacturer, the hospital industry spends only 2-3 percent in information management compared to 4-5 percent in other industries. Given the enormous amount of information generated in hospitals and its critical importance for patient care and billing, more computer information systems are clearly needed. And because of the historical quirks in the way systems were marketed to individual departments within hospitals, there is a serious lack of standards to ensure compatability of hardware and software. New systems will be demanded that put all of the clinical and administrative departments of the hospital in touch with each other.

5.3 R & D Consolidation

There also seems to be a tendency to consolidate R & D efforts in several ways. First, there is "a lot more introspection on whether the market will accept new products." This has had a depressing effect on firms adapting existing technology to other illnesses. One company was attempting to adapt its pacemaker technology to an implantable artificial larynx but discontinued its program several years ago as being too risky given long FDA approval times and uncertain hospital demand. Companies producing implantables to be used in one field like orthopedic surgery are also feeling limited in entering new fields with their technology because the market has narrowed and the risks increased.

Firms producing prostheses are said to be particularly affected by DRG payment. The cochlear implant device was one repeated example, but it was not always clear why these devices seemed problematic. It could be that the insertion of a prosthesis is included in a more general surgical DRG with a relatively low weight. It could also be that, being "invisible," hospitals are opting for the lower cost models. This was a complaint heard by manufacturers producing the top-of-the-line device. They claimed that hospitals were less interested in durability that device cost.

5.4 Research Versus Development

Another way manufacturers are concentrating their R & D is by focusing on Development. This seems especially true for larger firms that can use their size, engineering staffs, and production techniques to make real cost and performance improvements in their products. More money is being spent on automation, lowering energy use, and needing fewer complementary hospital inputs. Frozen drugs are one example. Many drugs are sold in lifealizable form, sealed in a vacuum in an uneven water solution. By dissolving the drugs and freezing them in a bag without water, they can be easily stored in hospital freezers until needed. This saves on inventory space.

Then there is the automated pharmacy. Instead of a pharmacist making drug dosages to order, a machine is loaded with a wide range of basic drugs that can then mix and dispense pills in sealed containers. All checks are done by a computer in the machine to ensure biocompatability. The process raises the pharmacist's productivity while enabling pills to be returned to the machine if unused. As one executive put it, "now we have more rewards for doing what we know how to do and not for coming up with a better approach to the illness."

5.5 Innovation by "Portfolio Management"

If larger companies are encouraged to concentrate more and more on Development of existing products, albeit in an effort to make them more cost effective, what happens on the research side? How do they continue to innovate? The answer is often through "portfolio management." Instead of developing and funding new ideas internally, larger firms simply buy out smaller, innovative, firms. One reason for this is related to organizational incentive structures. Divisions within a corporation producing a given line of products lack the incentive to innovate themselves out of a job. They are excellent at using money to further develop their products, to make them more efficacious, more cost effective, but not in coming up with an entirely new way of treating the illness or the problem. It is simply better to leave most of the basic research to others, then acquire them at some point and operate them jointly, one as a current money maker, the other as a hedge against the future.

Another reason why many medical device firms rely on portfolio management for their innovation is their unstated relation to the stock market. The market perceives these firms as primarily developers, manufacturers, and distributors, and not innovators in the true sense of the word. They are expected to take smaller firms' ideas when they have reached a certain threshold of success and maximize the extra profits that can be gained from scale economies of production and distribution.

This is not to say they do no innovation. Rather, they rely on universities, independent research labs, and the government to produce the bulk of new ideas. They often fund academic researchers and technology centers with partial rights over any subsequent patents. They also convene expert panels of physicians from all over the world to find out what physicians want in the operating room or their office, or what the latest innovative trends are.

5.6 PPS, Firm Size, and Innovation

It is generally recognized that small firms or groups innovate at higher rates than larger ones. This seems particularly true in the medical device industry. Within the device industry, relative R & D expense varies indirectly with company size, with smaller companies spending almost double the larger industry average. The smaller companies' commitment to R & D is depicted in Table 7 which describes rates of innovation in five (SIC) medical device categories. In 1982, small companies (firms that have fewer than 500 employees) manufacturing X-ray and electromedical equipment had 2.49 more

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TABLE 7

RATES OF INNOVATION IN FIVE SIC CODE MEDICAL DEVICES CATEGORIES[a]

Standard Industrial	Innovations in 1982		Industry Employment in 1977[d] (thousands)		
Classification (SIC) code[b]	Small Firm[c]	Large Firm	Small Firm	Large Firm	Innovations per employee Small Firm/Large Firm
3693	10	17	5.9	25.0	2.49
3841	36	30	11.7	31.5	3.23
3842[e]	33	30	17.9	36.0	2.21
3843	2	0	7.1	9.2	na[f]
3851	2	9	11.1	18.9	0.38
TOTAL	83	86	53.7	120.6	2.17

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[a] Innovations were published in 1982 trade journals.

[b] The five SIC codes are as follows: 1) SIC 3693 (X-ray and electromedical equipment), 2) SIC 3841 (surgical and medical instruments), SIC 3842 (surgical appliances and supplies), 4) SIC 3843 (dental equipment and supplies), and 5) SIC 3851 (ophthalmic goods).

[c] Small firms have fewer than 500 employees.

[d] Employment in 1977 is used because a lag in journal publication of 4.3 years between invention and innovation was found in a detailed analysis of 375 innovating firms.

[e] This analysis excludes four innovations in SIC 3842, because the innovating companies could not be found in published directories.

[f] na indicates information not available.

Source: Office of Technology Assessment, Federal Policies and the Medical Devices Industry (October 1984).

*Taken from Health Affairs, Summer 1985.

innovations per employee than larger companies (see last column). Small companies producing surgical and medical instruments had a rate of 3.23 innovations per employee, while those producing surgical appliances and supplies had 2.21 more innovations per employee than their larger competitors.

Size inhibits innovation because any changes must fit into an established system that is resistant to change of any threatening kind. But more important, the economic and technical barriers to entry appear quite low. Small groups, or even individual physicians, can raise enough venture capital to outfit a small lab. Out of such labs come pacemakers, infusion pumps, heart valves, bone growth stimulators, CAT scanners znd the myriad other innovations that constantly push back the envelope of medicine. New firms appear rapidly in the general field of medicine, but most are eventually bought out by a few large companies when it comes time to producing and marketing the product. What happens to small enterprises today will determine, in large part, what innovations will come to market ten years from now.

It is not at all clear what the effects of PPS are on small firms. Fixed DRG rates obviously raise the risk of marketing innovations, but whether this has much effect on new innovators is less certain. For anyone inventing a new life-saving technology, the returns are still extraordinary, even if they never personally bring the product to market. Moreover, a new market for cost cutting innovations has opened up in a heretofore indifferent cost-based environment. Underlying developments in computers, biotech, ultrasound, lasers, and fiberoptics further add to the menu of innovative opportunities that small groups can build on.

Smallness becomes a major barrier, however, beyond the early stage of discovery. First, and formost, is the 6-8 years to receive FDA approval for general distribution. Add to this 1-2 years for HCFA and private insurer reimbursement coverage. Many small companies lack the capital (or patience) to get completely through such a long gestation period.

Then there is the serious distribution problem mentioned earlier. There are over 5,000 short-term acute care hospitals spread throughout the United States, each operating in very localized markets. While many have organized into systems which would simplify device marketing, the sales force and distribution network required still strongly favors the larger firm.

Three key questions remain to be answered before the future of medical innovation can be foretold. First, what will be the rate of formation of very small, innovative, firms? Second, how many of the fledgling innovators have or will fail before making it all the way through FDA approval, HCFA coverage, and initial marketing to hospitals? And third, will large companies become more innovative on their own if the stock of small innovators is depleted?

In any event, there is general agreement that the industry will become more concentrated in the future. The creation of new innovators is very likely to slow down, first of all. Then larger companies will buy out medium-sized ones to take advantage of scale economies in production and distribution. This is a natural consequence of a narrower market for many devices, greater price competition among hi-tech commodities, and a drive to diversify the increased risk brought on by fixed payment rates. Ironically, it is the history of competition that it breeds concentration. The lack of price competition in the medical device industry has certainly allowed enormous variety in what and how products get produced. Variety has been further encouraged by strong underlying technical change in other industries, e.g., computers. Now it is likely that innovation will be funnelled through fewer small and large firms. Whether fewer entry points will seriously harm the overall rate remains a major question.

5.7 Importance of Being "First in"

The importance of being "first in" can be a harbinger of technical innovation. Yet, manufacturers are far from agreed whether it is an advantage or disadvantage. Some note that in unregulated industries like electronics it is not necessary to be first-to-market, as it is easy to leapfrog competitors and undersell with a better product. They argue that barriers to entry in a highly regulated industry like medical devices make being first in more important.

On the other hand, others argue that long FDA approval lags and other regulations discourage early innovators. Better to wait until the first FDA approval is received, then make slight alterations in device performance to avoid patent infringement. There are always ways to build a laser, a defibrillator, and infusion pump that can avoid a lawsuit and shorten development times. One industry analyst believed that a hi-tech innovator had about 11 months before the first competitor entered the market with FDA approval. In two years, the original firm had two competitors, and after five years, several serious competitors; this, despite the fact that they all would have to receive FDA approval to market and avoid patient infringements. Given that HCFA coverage decisions did not come for two years after the first FDA approval, the window of extraordinary returns was quite small.

Another big disadvantage to being first in under fixed DRG rates is the limited pricing flexibility it affords. Manufacturers of high risk technologies naturally expect very high mark-ups to recover years of investment. These were possible under cost-based reimbursement, but much less so under prospective payment--particularly if the innovation is targetted to the elderly.

6.0 OTHER BARRIERS TO INNOVATION

DRG prospective payment is not the only barrier to innovation, nor is it generally regarded as the most constraining. Several other barriers discourage the development and marketing of new technologies. How important each is depends upon the nature of the technology.

6.1 FDA

The Federal Drug Administration has responsibility for reviewing the safety and efficacy of all new medical devices. This review is most rigorous for the Class III devices that pose significant clinical, or life-threatening risks to the patient, often taking 6-8 years. Unless a manufacturer successfully demonstrates the safety and efficacy of its product, it cannot even market it. Given the length of the process, and the conditions under which the FDA approves the use of the device, it is understandable why most firms say the FDA is the major barrier to innovation. None, however, would like to see the process eliminated, only streamlined. It is hard to gauge how important prospective payment is over and above FDA approval in discouraging innovation, but it seemed marginal--at least to this point.

Perspectives on the equity and efficiency of the approval process vary. Some manufacturers felt that "FDA staff were fair and easy to deal with" while others claimed significant bias against new technologies and unnecessary delays. While five firms is too small to generalize from with confidence, it appeared that larger firms had an easier time working with the FDA. This may be due to their greater experience with the process and to a larger staff of lawyers, engineers, and clinicians. They also have the advantage of diversification. With several innovations in the approval pipeline, they are less dependent on the final outcome and the timing of a single decision.

Firms also felt that FDA had become more responsive in recent years; that its staff was more concerned over the complete management of illnesses and the broader role of technologies in restoring function and well-being. They also felt that the AIDS epidemic had forced the agency to rethink the negative costs to society of withholding approval. In any event, firms were still planning on at least a five year lead time between initial design and final FDA approval.

Manufacturers also noted a trend towards off-shore R & D because of FDA policies and time lags. Several companies were funding clinical trials in Europe under the direction of a world-renowned physician. European countries have fewer restrictions and rely more on the physician's reputation. Trials can start earlier and finish quicker than in the U.S., with the results then submitted to the FDA for an abbreviated review.

American firms had two concerns about this process, even though they recognized its advantages. First, it shifted R & D investments out of the U.S. to the disadvantage of the domestic research community. And second, it gave an advantage to European-based companies like Siemens who already had established European research centers and were used to working with the regulatory agencies.

Finally, one firm noted the all-or-nothing nature of the approval process. After receiving a limited approval for clinical trials, i.e., an IDE, a lengthy trial and review process is necessary before any marketing can begin. If some middle ground could be reached on the most promising devices that would permit limited marketing, the financial risk and costs could be substantially reduced.

6.2 HCFA Coverage

Firms clearly recognize the need for a stringent FDA approval process, a process that by definition must take several years. They are much more troubled by the additional review performed by staff at HCFA's Bureau of Eligibility, Reimbursement, and Coverage. They claim this adds roughly two years to the process and is largely redundant. Delays are crucial in that FDA approval is only the necessary condition for successful marketing; reimbursement coverage is also needed if the market is to be financially viable.

HCFA review is not intended to be redundant in the sense that it is supposed to focus on device effectiveness rather than safety and efficacy, which are more general criteria. Instead of asking whether the device is safe and does what it is supposed to do at least for some class of patients and conditions, HCFA asks the broader question of whether the device is economically preferrable to existing modalities of care and under what conditions.

One example of the distinction involves ambulatory insulin pumps for diabetics. Instead of using pills or needles, the implantable pump could give regulated doses of insulin as necessary. While FDA approved the technology, one large firm stopped pursuing it once HCFA clinical research determined that it was not cost effective over existing methods and denied reimbursement for this use. While the technology could be applied to chemotherapy and other illnesses, the demand was not considered extensive enough to warrant continuing.

One very positive outcome of HCFA's emphasis on cost effectiveness seems to be the spread of technology assessment among manufacturers. Many are not comfortable with the time delays, but some say it does encourage a more thorough defense of the innovation against existing technologies. It may also be fostering some novel risk sharing arrangements. One manufacturer having trouble getting third party coverage for a new device has developed a novel technology assessment to allay insurer's concerns over inappropriate use. The marketing involves a very detailed set of criteria under which the device should and should not be used. They have even gone so far as to offer to pay half the surgical and other costs if the device fails when properly used. Naturally, the rest of the industry has reservations about such a marketing technique. Yet, given the explosion in new devices and their attendant costs, some form of risk sharing may be preferrable to strict government sanctions and denials of coverage.

This may also address the alleged "catch 22" of firms having to prove cost effectiveness in various settings without data on how practitioners actually use the device. Without coverage, hospitals and physicians are very reticent to buy the device. But without information on its use in various hospitals with different patients, how can a firm show its full range of cost effectiveness (or lack thereof). Under cost-based reimbursement, HCFA was in a very tenuous position in covering new technologies because of the lack of financial incentives to use the device appropriately. It would seem that DRG payment that bundles the device into the overall rate without raising outlays in the first instance mitigates HCFA's concern somewhat. Of course, there is still the physician's fee for using the device, which remains unbundled at this time. Achieving the right combination of manufacturer risk sharing, HCFA technology assessment and coverage limitations, and indirect controls via bundled pricing should be a definite goal in the next few years.

6.3 Physicians

The medical community can be both a help and a hindrance to innovation. A select few play a critical role at the beginning, either by actively conducting research or by suggesting new areas of exploration. Then, as devices are marketed, some specialists eagerly adopt them for clinical as well as financial reasons.

Physicians can also set up barriers to diffusion, however. Orthopedic surgeons, for example, may not be inclined to use bone growth stimulators if they mean less graft surgery. Or they be less inclined to use noninvasive models over implantables that generate surgical fees and require hospital admission. One firm with a noninvasive model designed such an implantable given the resistance of surgeons to noninvasive solutions. This was also a case where hospital and physician incentives coincided so there was no pressure from administration to use the cheaper alternative.

While numerous instances of physician reluctance to adopt new devices can be cited, devices in general are complementary to the physician's practice. They not only improve clinical outcomes, but they add significantly to practice revenues. In this respect, DRG payment has led to an inadvertant boom in the ambulatory device market, which is a topic we return to later.

6.4 Product Liability

Most manufacturers accept product liability as a fact of life. Yet, it is still an important barrier to innovation at the margin. Inserting implantables with toxic drugs, pain killers, and dangerous electronic pulses, for example, allows no room for malfunction. Even nonfunction is costly given the readmission costs and surgical risks associated with device replacement.

While they are rare, examples of manufacturers put out of business by a single recall of a pacemaker or infusion pump do occur. The personal inconvenience, not to mention costs, of recalling a product are very large. They are also of a different kind than recalls of other consumer products. Hence, the very nature of medical devices demands a higher level of product reliability and accuracy which adds substantially to costs. It also adds to insurance coverage. It seemed clear in talking with firm executives that product liability played a definite role, both at the development stage as well as in the production of the device. It also seems inconceivable that degradation of the product that could be hypothesized under fixed DRG rates would be allowed to happen given the constant liability threat.

There are even examples of the overuse of certain devices as physicians anticipate malpractice suits. Orthopedic surgeons, for example, will use bone growth stimulators after revision of a fracture even when it is not indicated by previous difficulties in healing just to be able to say they did everything possible for the patient. The manufacturer may then be criticized for unapproved use of the device by HCFA or other insurers.

6.5 Other Insurers

Private insurers like Blue Cross/Blue Shield are much less of a barrier than HCFA in extending coverage, according to manufacturers. Not all carriers are the same, however, causing manufacturers to target their sales efforts in certain states like North and South Carolina and Florida perceived to be liberal in their coverage policies. Because Blue Cross/Blue Shield plans cover so many patients, manufacturers are very dependent upon their coverage decisions. On the other hand, because HCFA makes a blanket coverage decision for all its beneficiaries nationwide, its decision is usually much more important than the decentralized decisions of plans in the various states. The greatest "fear" is that stringent HCFA decisions will begin to permeate the industry, narrowing the market even further.

7.0 AMBULATORY SITE SHIFTS

Devices can be classified into two groups: one that is uniquely inpatient, and another that can be found in both an inpatient and an outpatient setting. Clearly, the impact of PPS depends on how hospital-specific the product is. For heart valves, pacemakers, infusion pumps, prostheses, and the like, DRG payment rates can have a major inhibiting effect on demand due to the lack of a non-hospital market. Firms producing devices that can also be used in an outpatient setting would appear to be on very different footing; in fact, they probably have been greatly helped by PPS.

One of the best examples of the "alternative site syndrome" is ultrasound imaging. Until a few years ago, practically all of the cardiac imagers for monitoring heart performance noninvasively were found in hospitals. These models have a wide selection of features and run from $70-150,000. Ultrasound was a hi-tech, visible piece of equipment important to the hospital's overall image.

When PPS was introduced and the PROs began to deny admissions simply for diagnostic testing, the whole focus of the market shifted to the doctor's office, surgicenters, nursing homes, and home health agencies. But even at $70,000, the price was too much for most physicians, so Hewlett-Packard and others brought out a new, low cost, imager specifically for the office. It was a basic desktop model that could do most of the necessary tests. Price was an issue in this market given the lack of capital of most physicians (relative to hospitals) and their much lower volume.

Miniaturization and other improvements have certainly facilitated the production of "downscale" models, but manufacturers realize that the market has been greatly enhanced by the economic pressures to do as much diagnostic testing as possible outside the institution. In fact, this market has been a win-win situation for manufacturers. The inpatient market for imagers is still strong given technical improvements and the "image building" nature of the technology, and anything that has been lost in terms of inpatient volume has more than been made up on the outpatient side. When the patient had to be admitted to receive ultrasound, this served as a natural access barrier. Now that this technology is diffusing rapidly to physician's offices, they are far more convenient to both patients and physicians. And there are no utilization restrictions or certificate of need limitations.

To the degree possible, manufacturers were trying to respond to the incentives to diversify into alternative site markets. We have already noted that how they respond goes back to the very basics in allocating R & D monies. As the technology is already established in an inpatient setting, it is simply a matter of focusing the engineers on the development issues of size and cost. These are the tasks that medium and large scale firms do best. Once sucessful, they then build on their existing sales staffs and local distribution systems to meet physician needs in their offices.

Larger firms have taken this even a step beyond selling downscaled units outside the hospital. They have entered into "alternative site joint ventures" with hospitals to enable them to capture some of the outpatient business that used to be provided inpatients. Baxter-Travenol, for instance, has developed exclusive arrangements with hospitals that refer patients to the company for their home health needs, e.g., drugs, linens. The hospital makes the drugs in their pharmacies and their RNs provide the home care, with the firm providing the distribution network. Many of the "commodity device" firms are in a unique position to assist hospitals in following patients pre- and post-hospitalization, which also gives them preferred access in selling their devices in an unregulated market.

8.0 BASIC SCIENCE INNOVATION

We have mentioned before the underlying trends in technical change that foster much of the innovation in medicine. In this section, we discuss two of these in more depth under the rubric of "innovative opportunities."

8.1 The Computer and Medical Innovation

In the last thirty years, the computer has transformed industry, transportation, energy, communications, and consumer durables. Greater speed, miniaturization, and time sharing, enable us to control the pace of the assembly line, send unmanned spacecraft outside the solar system, and carry out complex numerical calculations instantaneously on our hand calculators. And it does this far cheaper and faster than even five years ago. If there are any limits to this technology, either in function, speed, or in application, we have not yet reached them. Private industry continues to invest very large sums of R & D in this technology worldwide, with spillover applications to all industies.

In medicine, computer applications have been particularly innovative. The most obvious is in management information systems for hospitals, nursing homes, physicians' offices, and for insurers paying the bills. There are many other important areas, however, that may be less visible but much more important in improving the nation's health. Computers absorb the complex information received by noninvasive ultrasound and other forms of electronic transmission and transform it into easily interpretable diagnostic images of the heart, the circulatory system, the kidneys, and other organs. They manage networks of remote monitors linking patients within and outside the hospital to nursing stations. They are the brain inside autoanalyzers breaking down the elements in patients' urine and blood. And in miniature form they control the rhythm of implantable pacemakers, infusion pumps, and electronic bone stimulators.

It is hard to imagine what medicine was like forty years ago without the computer. It is equally as hard to imagine where it will be forty years from now as computers become faster, cheaper, and always smaller. Consider just the advantage of miniaturization. The first pacemaker of the '50s weighed 12 pounds and was worn strapped to a person's back. Now it fits on one finger. Most other implantables are the size of hockey pucks and offer perfect portability, freeing patients to lead normal lives.

The miniature implanted computer emits very controlled doses of pain killers, spasm suppressors, and chemotherapy drugs, and can defibrillate arrhythmic heart beats with exact electrical shocks. It can do these tasks without the aid of a nurse or a physician any time night or day regardless of the patient's activity level.

Moreover, the computer is more accurate and reliable than humans. It can analyze blood more specifically, enhance x-rays and produce three dimensional views of the body that improve the radiologist's "eyesight", and can respond more quickly to abnormalities of heart rhythm.

And as it gets smaller and smaller, the computer shifts the site of diagnosis and treatment away from the hospital to the clinic or doctor's office and, ultimately, to the patient himself in the form of implantables.

What does PPS have to do with these trends? By paying fixed rates per discharge, PPS encourages cost-reducing computer applications in the hospital. Management information systems are the premier example, but centralized monitoring that reduces nursing costs is another. PPS also encourages a shift of care to alternative sites which coincides with the miniaturization and declining cost profile of "clinical computers."

Yet, computers, like the cotton gin, are a mixed blessing. Instead of reducing overall costs (or discouraging slavery) by substituting machine for human, they multiply the demand for specialists and auxiliary personnel. Engineers design and produce infusion pumps, for example; cardiologists and neurosurgeons implant them; nurses help patients recover from the operation and then they monitor the pump's performance; delivery men supply the drugs that go inside them; and so on. Most importantly, instead of the patient coming to the machine, at considerable inconvenience and travel cost, the CAT scanner, lithotripter, cardiac imager, etc. are coming to the patient. This takes place in an outpatient setting without the utilization review so prevalent today in hospitals. Unless reimbursement for these device-intensive procedures changes, irrespective of where they are provided, health care device costs will continue to rise rapidly. Extensive insurance coverage discourages patients and their physician agents from using equipment appropriately, treating it like a free input. In the past the major constraint has been physical access and not the ability to pay, but as the computer shortens the distance between patient and machine and makes testing and treatment more convenient, this barrier, too, will fall.

8.2 The Biotech Revolution

Even more fundamental to the future of medicine than the computer is the biotech revolution. Health care involves two kinds of problems, those externally imposed on people and those caused by internal "malfunctions." Car accidents, poisonings, and drinking are three examples of externally imposed conditions requiring medical attention. Many illnesses, on the other hand, have a genetic origin, including congenital heart failure, cancer, and cataracts. The biotech revolution is a megatrend aimed at reducing and eventually eliminating many of the genetically-induced illnesses in the population.

Although most of the growth in drug therapy is not biotech per se, it is a harbinger of things to come, as medicine begins to treat causes rather than symptoms. This revolution will have profound implications for Medicare spending in the next 50 years, over and above the aging population and device innovation more generally. Suppose that biotechnicians find a genetic cure for cancer. This illness alone accounts for a substantial portion of the entire Medicare bill. A relatively inexpensive, prophylactic solution could save huge sums of money and wasted resources, although the cost of other illnesses in the elderly would certainly rise.

With any prophylactic treatment comes difficult coverage decisions because it is never clear who is most at risk for the illness. Treating everyone can be extremely costly, and guidelines would be necessary to insure proper access. Of course, much would depend upon the initial treatment cost.

The biotech revolution will also reinforce the "alternative site syndrome." Much of the genetic treatment will be done using drugs on an outpatient basis rather than in the hospital. As mentioned before, this will make regulation and determination of appropriateness more difficult. The current PPS only focuses on inpatient care, which has the effect of truncating the episode of illness and leaving outpatient use alone. Diagnosis will occur earlier as well and result in most, if not all, treatment in an outpatient setting. This will radically change the mission of acute care hospitals in favor of treating externally imposed illnesses. And over time, the inpatient DRGs will shift in relative importance and become a smaller part of overall Medicare spending. Thus, the truly long run question facing HCFA and society in general is how to financially manage this biotech revolution, given that its main site is likely to be other than the hospital.

9.0 CONCLUSIONS

Many of the short-term effects of PPS on medical device innovation and diffusion seem positive. The market became immediately more competitive, with prices on supplies and hi-tech commodities falling. The rate of inflation has also been much lower than formerly. This has raised the cost consciousness of manufacturers in producing their products and of hospitals in using the devices. Manufacturers rely much more on cost effectiveness arguments in selling their devices and in showing when best to use the device.

Nor does there seem to be any reduction in R & D spending in reaction to a narrower hospital market and price squeezing. The underlying demographics and technical change are viewed very favorably by manufacturers. And in the short run, the initial price "crunch" was softened by the capital cost passthrough and historically high hospital profits that were plowed back into new equipment.

Finally, two other "safety valves" have further diluted the possible negative effects of prospective payment. One is the burgeoning ambulatory market as physicians scramble to provide diagnosis and treatment that used to be done on an inpatient basis. The other is the world market which continues to grow and become increasingly important--at least for many devices.

With all of these positive trends in mind, several technical concerns bear further research. For example, manufacturers appear to be focusing on select DRGs and hospitals in marketing their products and targetting their R & D. They are looking to the higher paid DRGs involving surgery that have large numbers of patients. This may be biasing innovation away from less expensive medical solutions. They are also focusing on teaching and urban hospitals in marketing devices because of their higher DRG rates across the board. While this might lead to a more appropriate concentration of new technologies in larger institutions, it may also lead to access problems in some rural and urban communities.

Manufacturers are also identifying "high Medicare DRGs" as possibly less financially sensitive to innovation. This is an immediate concern of theirs in that hospital rates are fixed for the majority of Medicare patients in these DRGs, and hospitals must bear the extra cost of using the device. It is also a long-run concern as it discourages hospital adoption within a given DRG, further limiting the sensitivity of DRG rates to innovation.

Also problematic is the readmit bias inherent in PPS. Hospitals have little incentive to purchase devices that lower the episode-of-care costs by avoiding readmissions. This is especially true if the device raises the initial cost of hospitalization.

There also seems to be a general concern over the inadequacy of the prosthetic DRGs. If these are systematic losers under PPS, then innovation in this all-important area could be stifled. Research is needed on whether this is, in fact, the case, and whether it is related to device or other cost factors.

A final concern of manufacturers is the alleged redundancy of HCFA coverage decisions with the FDA. While it is recognized by the industry that insurers are more concerned over cost effectiveness that FDA, the assessment process is lengthy and not without political overtones. Modifying the reimbursement system to obviate the need for such a lengthy review would help both the government and industry.

In spite of these concerns, the future of the medical device industry seems positive--at least for 20-30 years--barring dramatic reductions in prospective rates or physician reimbursement. The aging of the population guarantees a long-run demand. The inexorable trend toward smaller, faster, and cheaper computers, reinforced by the biotech revolution, assures a steady growth in the locus of opportunities for innovation.

Less clear are the effects of a changing industrial structure. More price competition means more cost competition, which means a larger, more concentrated industry to take advantage of inherent scale economies. While large companies can be quite efficient at producing high quality devices, it is less clear what kind of innovators they will be. The crucial role of start-up and small firms in this industry is undeniable. If the greater market risk on top of FDA approval lags, product liability suits, etc. discourages new innovators, then the job of continuing past innovative performance will fall on larger, established firms. This trend needs to be watched closely.

Another potentially troublesome trend is the movement of care away from the hospital to the physician's office or clinic. Although a definite new market for manufacturers, ambulatory care presents serious cost questions for insurers, of which Medicare is the single largest. Physicians are essentially unregulated in their purchase of medical devices for their own practices, nor are there any meaningful limits on the kinds of patients they treat using these devices. Unless new ways of paying physicians are instituted that bundle the device costs along with other services, improved patient access will eliminate the last constraint to inappropriate use. Fully insured, without having to spend the time and inconvenience of being admitted, the patient and his/her physician agent will be free to use the available technologies "at their leisure," so to speak. How to regulate or pay for device use in an appropriate manner on an outpatient basis will become a major issue for all insurers in the next 5-10 years as manufacturers enter the market in a big way. The technology is there now; it is only a question of adapting it to an alternative site on a scaled down basis.

REFERENCES

Assessing Medical Technologies. By the Committee for Evaluating Medical Technologies in Clinical Use. Washington, D.C.:National Academy Press, 1985.

Garrison, Louis P., Jr., and Gail R. Wilensky. "Cost Containment and Technology." Health Affairs, 5, No. 2, Summer 1986, 46-58.

Office of Technology Assessment. Federal Policies and the Medical Device Industry. OTA-H-230. Washington, D.C.:OTA, 1984.

Pollard, Michael R., and Gary S. Persinger. "Investment in Health Care Innovation." Health Affairs, 6, No. 2, Summer 1987, 93-106.

Read, J. Leighton, and Paul M. Campbell. "Health Care Innovation: A Progress Report." Health Affairs, 7, No. 2, Summer 1988, 174-185.

Russell, Louise B., and Jane E. Sisk. "Medical Technology in the United States: The Last Decade." International Journal of Technology Assessment in Health Care, 4, No. 2 (1988), 269-286.

White, Jane K. "Health Care Innovation in An Era of Cost Containment." Health Affairs, 4, No. 2, Summer 1985, 105-118.

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